SINGLE SIDEBAND
ANALYZER SYSTEM
MODEL SSB-50
VOLUME II

ALFRED

SINGER
INSTRUMENTATION

INSTRUCTION MANUAL

SINGLE SIDEBAND
ANALYZER SYSTEM
MODEL SSB-50
VOLUME II

(Containing Models MF-50,
RF-8, REC-2 & TTG-3 Manuals)

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Instruments should be returned only on prior written authorization from the Singer Representative or the factory(1). Warranty repair will be made upon written request. Please provide the following information in order to expedite our processing of your instrument:

1. Model or Type
2. Serial Number
3. Description of trouble(2)
4. Test instruments used
5. Approximate date instrument was placed in operation
6. Approximate number of hours of use
7. Has maintenance action been previously requested?
8. Other comments

Upon receipt of this information our Service Department will send you service data or shipping instructions. Upon receipt of shipping instructions forward the instrument to the factory prepaid. If requested, an estimate of charges will be made before work begins.

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Contact Ballantine Operation, P.O. Box 97, Boonton. New Jersey, 07005 for Ballantine instruments
(2) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken, and any other relevant data.

INSTRUCTION MANUAL

MAIN FRAME

MODEL MF-50

Serial No. _____

Instruction Manual No. 110-5036

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ADDENDUM

for

MODEL MF-50

I. PURPOSE.

To correct errors in schematic diagrams.

II. ADDENDUM.

a. Change J1-R to read J1-S.
b. Change J1-S to read J1-R.
c. Change J4-8 to read J4-9.
d. Change J4-9 to read J4-8.

Addendum No. 589

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Figure 1-1. Model MF-50 Main Frame (Shown Installed in Optional Model CMF-50 Carrying Case)

SECTION I
INTRODUCTION

1-1. SCOPE OF MANUAL.

1-2. This instruction manual provides operating and maintenance instructions for the PANORAMIC* Main Frame, Model MF-50 (hereafter referred to as the Main Frame), manufactured by The Singer Company, Metrics Division. Included in this manual are a general description of the Main Frame, installation and operating instructions, theory of operation, maintenance information and data, a schematic diagram and a repair parts list. The Main Frame is illustrated in figure 1-1.

1-3. The information contained in this manual refers to the standard version of the Main Frame and is current only to the date of publication. Differences in equipment components, specifications and performance resulting from The Singer Company's continuous product improvement program or individual customer design and application requirements are described in addendum sheets.

1-4. PURPOSE AND USE OF EQUIPMENT

1-5. The Main Frame is primarily designed to operate with the PANORAMIC Models TTG-3 Two-Tone Audio Generator, RF-8 Tuning Head and REC-2 Range Extending Converter in the PANORAMIC Model SSB-50 Single Sideband Analyzer System. The Main Frame serves as a mounting enclosure and a source of operating power for these plug-in units.

1-6. GENERAL DESCRIPTION.

1-7. The Main Frame contains the regulated power supplies required to operate the TTG-3, RF-8 and REC-2. Since these power supplies are completely solid-state, very little warm-up time is required after turn-on. The Main Frame is designed to be mounted in a standard 19-inch rack. It operates from either a 95- to 130-volt or 190- to 260-volt, 50- to 400-Hz single-phase a-c source.

1-8. SPECIFICATIONS.

1-9. The electrical and physical characteristics of the Main Frame are listed in table 1-1.

1-10. TRANSISTOR, DIODE, FUSE AND INDICATOR COMPLEMENT.

1-11. Table 1-2 lists all transistors and diodes used in the Main Frame and table 1-3 lists the fuse and indicator lamp complement.

TABLE 1-1. SPECIFICATIONS

Output Voltages:	+15 and -15 volts, regulated
Line Regulation:	Better than 10 mv
Load Regulation:	Better than 20 mv
Ripple:	Less than 10 mv
Maximum Current:	250 ma (each supply)
Power Requirements:	95 to 130 volts, 50 to 400 Hz, single-phase or 190 to 260 volts, 50 to 400 Hz, single-phase, 9 watts
Operating Temperature Range:	0 to 55°C

(Cont'd)

*A Trademark of THE SINGER COMPANY

TABLE 1-1. SPECIFICATIONS (Cont'd)

Physical Characteristics:	
Height:	5-1/4 inches
Width:	19 inches
Depth	21-15/16 inches (Behind front panel)
Weight (less plug-in units):	16-1/2 pounds (approx.)

TABLE 1-2. TRANSISTOR AND DIODE COMPLEMENT

Reference Designation	Type	Function
Transistors		
Q1	2N1483	1/2 Series Regulator (+15 vdc supply)
Q2	2N3638	1/2 Series Regulator (-15 vdc supply)
A1Q1	2N3638	Constant Current Source
A1Q2	2N3642	1/2 Series Regulator (-15 vdc supply)
A1Q3	2N3642	Reference Amplifier
A1Q4	2N3642	Constant Current Source
A1Q5	2N3638	1/2 Series Regulator (+15 vdc supply)
A1Q6	2N3638	Reference Amplifier
Diodes		
A1CR1 through A1CR4	1N4002	Full-Wave Bridge Rectifier
A1CR5	1N659	Voltage Regulator
A1CR6	1N251	Temperature Compensation
A1CR7	1N251	Current Limiter
A1CR8	ZD8. 2B	Voltage Reference
A1CR9	1N659	Voltage Regulator
A1CR10	1N251	Temperature Compensation
A1CR11	1N251	Current Limiter
A1CR12	ZD8. 2B	Voltage Reference

TABLE 1-3. FUSE AND INDICATOR LAMP COMPLEMENT

Reference Designation	Type	Function
Fuses		
F1 and F2	3/8 amp, SLO-BLO (3/16 amp, SLO-BLO* for 230 volt operation)	Primary Power
Indicator Lamps		
DS1	2110 (Industrial Devices)	POWER pilot lamp

* Not Supplied

SECTION II
OPERATION

2-1. GENERAL.

2-2. This section contains installation and operating instructions for the Main Frame. The Main Frame has been factory tested and adjusted and is shipped in a ready-to-operate condition. Figure 2-1 is an outline dimension drawing of the Main Frame.

2-3. INSTALLATION.

2-4. To install the Main Frame in a standard 19-inch relay rack, place the Main Frame in the position desired and secure the front panel to vertical members of the rack with four screws. Determine whether the supply voltage is 115 or 230 volts ac and set 115V-230V switch S2 (located in the rear of the compartment in which the TTG-3 is normally installed) to the appropriate position. If the power is 115 volts ac, fuses F1 and F2 should have a rating of 3/8 ampere; however, when a source of 230 volts ac is used, the 3/8-ampere fuses must be replaced with fuses rated at 3/16-ampere.

2-5. After the Main Frame has been installed in the rack, and power considerations have been accomplished, connect the power cable supplied with the SSB-50 system between the a-c source and connector J5 on the rear of the Main Frame.

2-5. TURN-ON PROCEDURE.

2-6. To energize the Main Frame, set the POWER switch to ON; regulated +15 and -15 volts are then supplied to the TTG-3 and REC-2, and -11 volts is supplied to the RF-8 (through dropping resistor R3 in the Main Frame) when the three units are installed in the Main Frame.

2-7. PACKAGING INSTRUCTIONS.

2-8. The following packaging instructions provide information for short-term and long-term storage and shipment of the Main Frame.

2-9. SHORT-TERM PACKAGING. For short-term packaging, the Main Frame should be enclosed in a polyethylene bag and placed in a suitable carton for protection. The carton should be stored in a clean and moisture-free area. All accessories and literature should be securely fastened to the equipment in order to prevent loss.

2-10. LONG-TERM PACKAGING AND PACKAGING FOR SHIPMENT. Figure 2-2 illustrates the packaging procedure for the Main Frame.

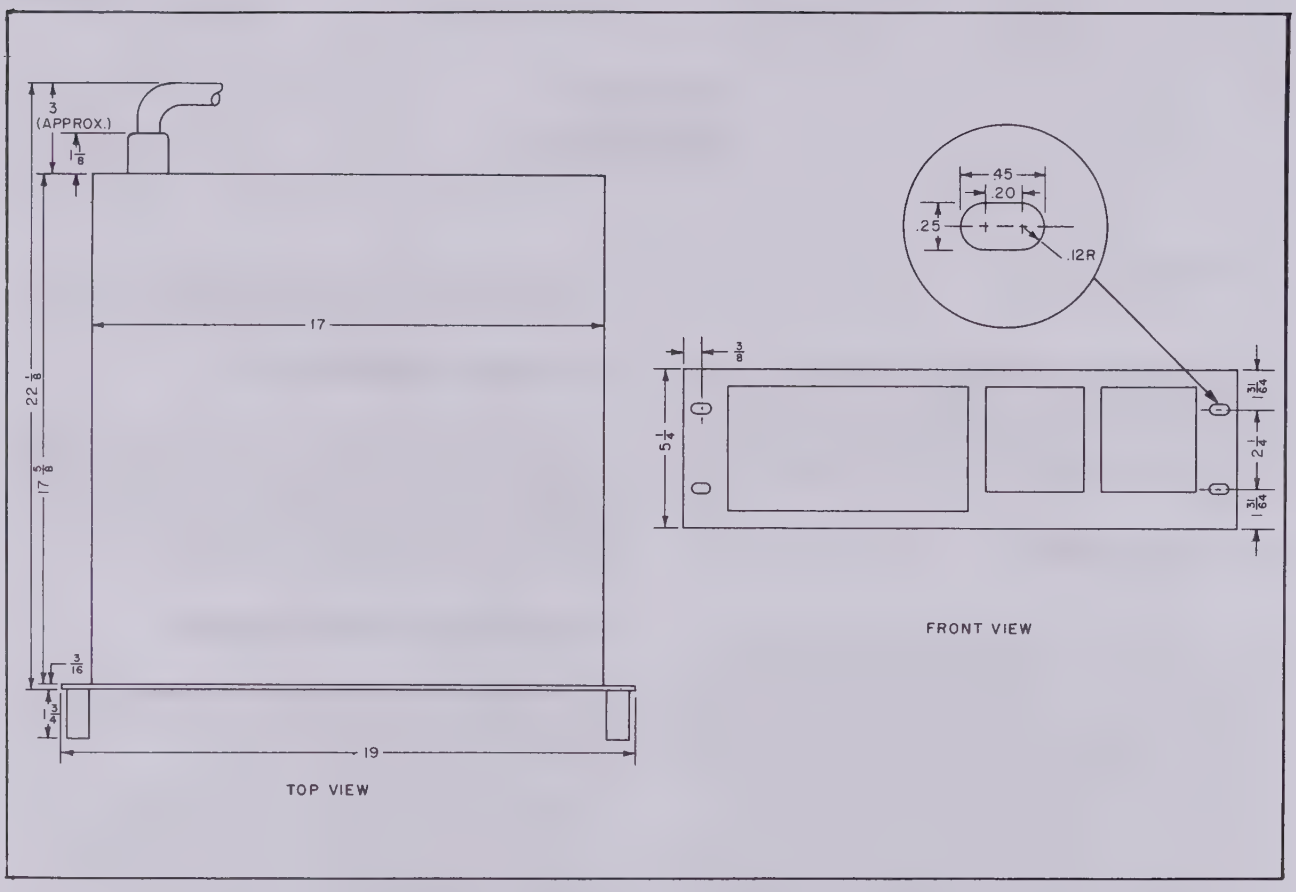


Figure 2-1. Outline Dimension Drawing, Main Frame

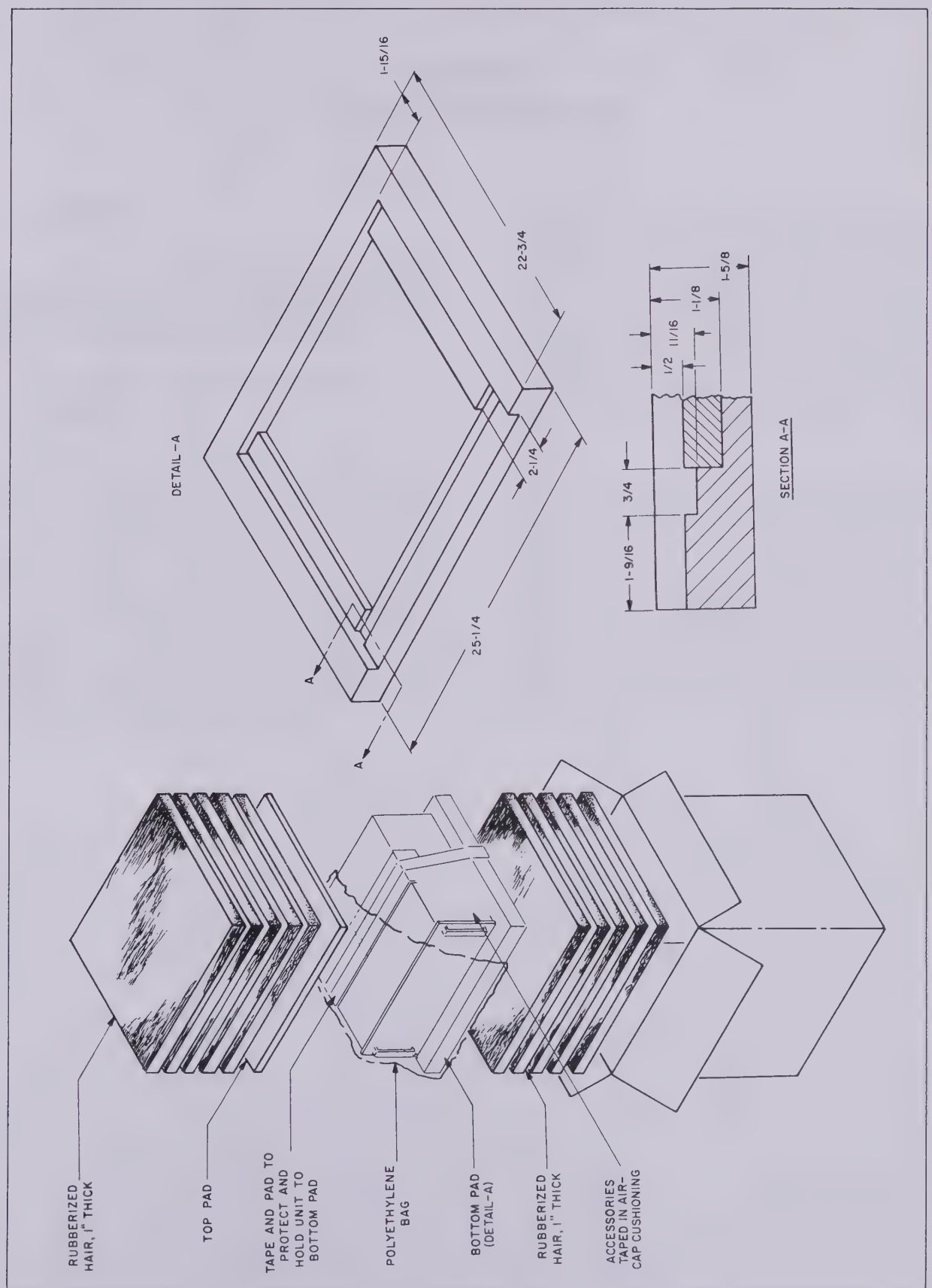


Figure 2-2. Packaging the Main Frame

SECTION IV
MAINTENANCE

4-1. GENERAL.

4-2. This section contains maintenance information for the Main Frame. No attempt should be made to repair internal components or make adjustments until the operator is thoroughly familiar with the information contained in this section. The performance of the Main Frame may be checked using the minimum performance standards checks provided to determine whether the equipment is operating properly. Adjustment procedures to restore the equipment to proper operating condition after the required repairs have been effected are also included in this section.

4-3. TEST EQUIPMENT REQUIRED.

4-4. The test equipment required for maintenance of the Main Frame is listed in table 4-1. Equipment having similar characteristics may be substituted for those listed in the table.

4-5. PRELIMINARY INSPECTION.

4-6. Preliminary inspection of the equipment is performed with the Main Frame withdrawn from its rack, all plug-in units withdrawn and without operating power applied. This type of check is designed to detect conditions that might otherwise lead to a breakdown. Frequent causes of equipment failure are overheating of components due to improper ventilation, accumulation of dust and dirt and/or loose connections and fittings. Inspection is carried out with emphasis on finding evidence of these conditions.

4-7. COMPONENT LOCATIONS. The location of components mentioned in the inspection routines and adjustment procedures are illustrated in figures 4-1 and 4-2.

4-8. PRELIMINARY INSPECTION ROUTINE. Table 4-2 lists the preliminary inspection routine for the Main Frame.

TABLE 4-1. TEST EQUIPMENT REQUIRED

Type of Equipment	Suggested Manufacturer Name and Model No.	Use
VTVM	RCA Model WV-98C	Voltage measurements
Digital VTVM	Non-Linear Systems Series 4800	Regulator adjustment
Oscilloscope	Tektronix 531A with Type L Plug-in	General waveform analysis
Autotransformer	General Radio Type W5MT3A	Minimum performance standards checks
Service Cable	Singer Part No. 556161-661	Allows TTG-3 to be connected externally

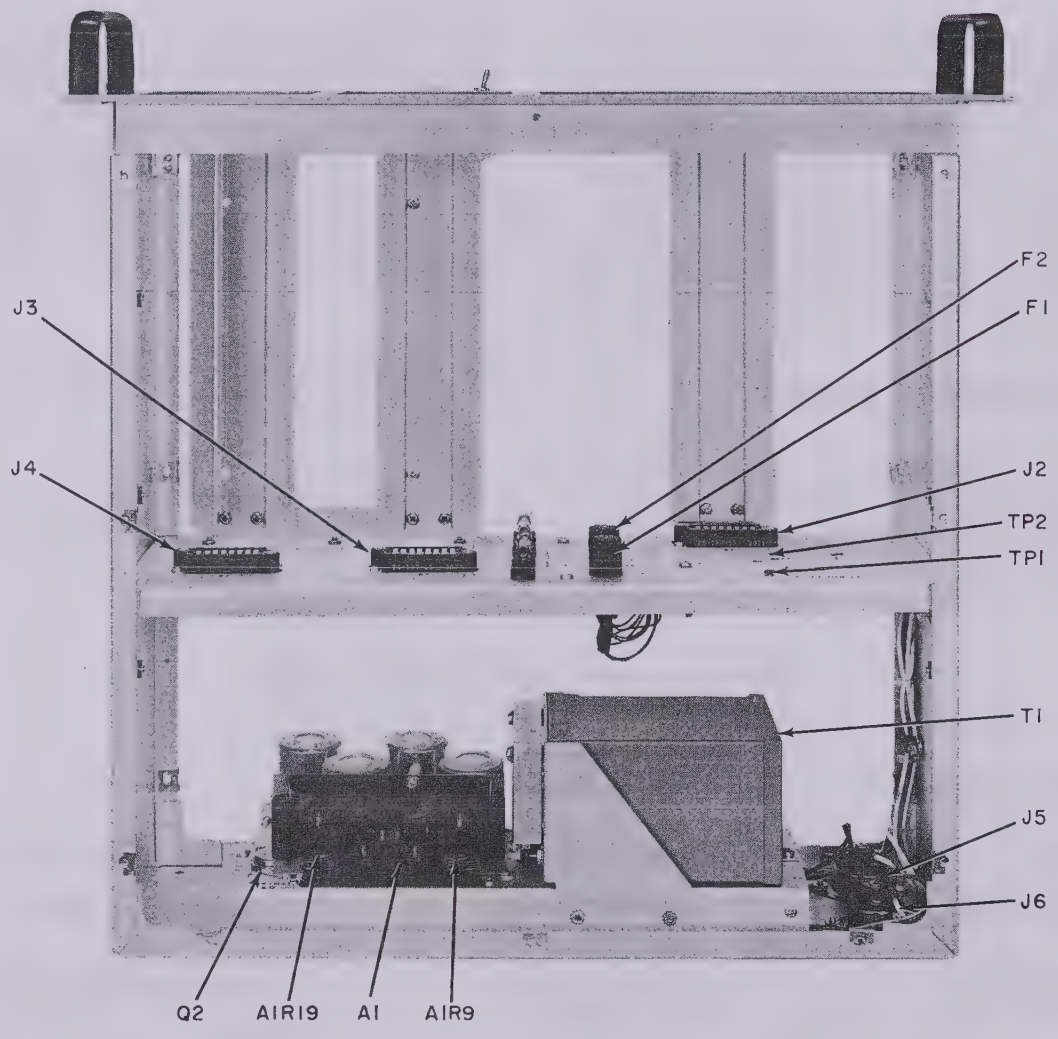


Figure 4-1. Main Frame, Top View

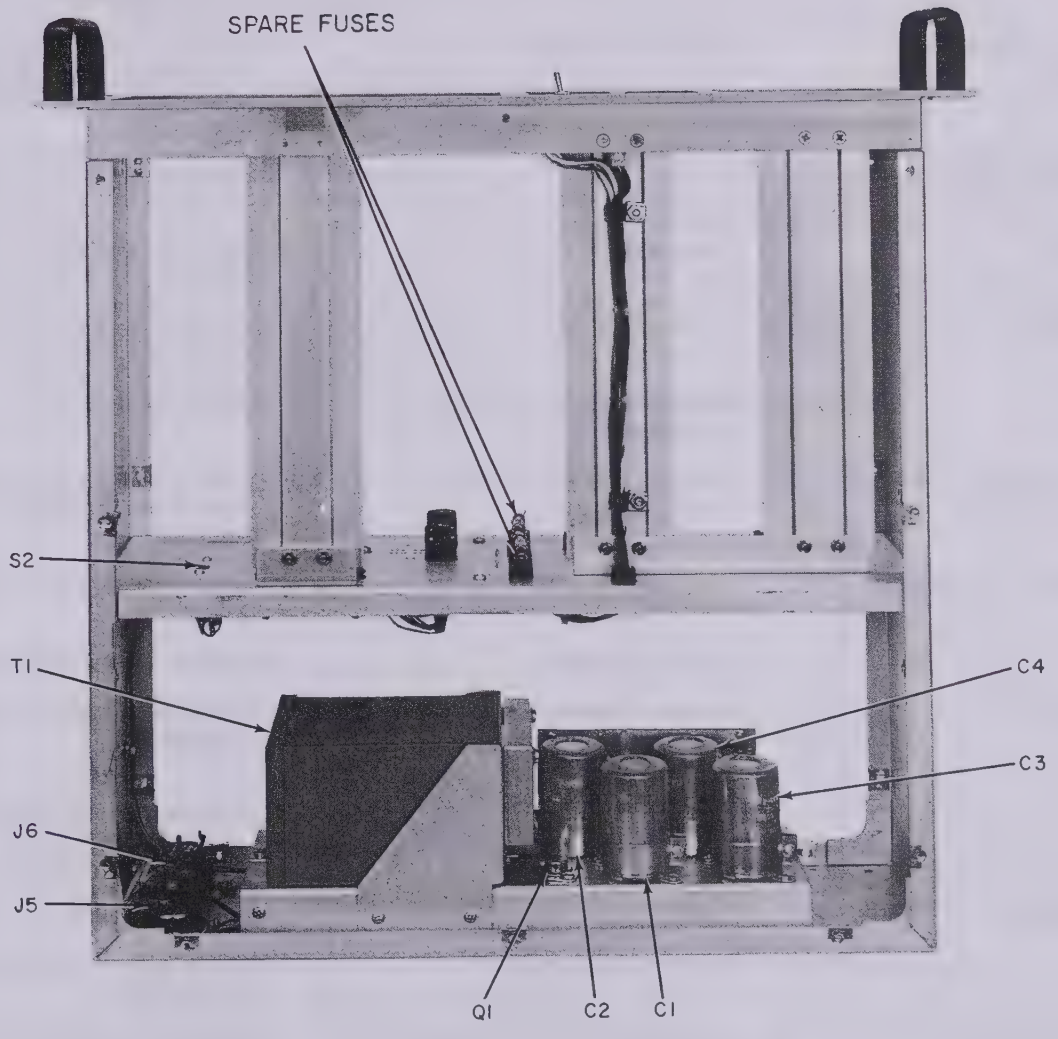


Figure 4-2. Main Frame, Bottom View

TABLE 4-2. PRELIMINARY INSPECTION ROUTINE

Item	Inspect For	Corrective Action
Connector at rear wall of module cavity	Bent or corroded contacts, signs of arcing	Clean contacts with cloth moistened with cleaning solvent trichloroethylene or equivalent. Replace jack if damaged or deeply corroded.
Main Frame and front panel	Dirt and corrosion	Clean with cloth moistened with cleaning solvent trichloroethylene or equivalent.
Knobs, screws, connectors, clamps	Looseness	Tighten using appropriate torque so as not to strip threads.
Switches	Looseness	Tighten mounting screws or nut.
Wiring	Looseness	Resolder, recable, or reclamp.
	Frayed, worn, or missing insulation	Replace as required.
Solder joints	Loose or cold solder connections; corrosion	Clean carefully and resolder, using a low-wattage soldering iron.
Printed circuit boards	Mounting looseness	Replace mating plug if required.
	Loose components	Resolder loose components.
Resistors	Cracks, chipping, blistering, discoloration, and other signs of overheating	Replace with exact match of original. **Note** Ensure that overheating is not due to other defective components.
Capacitors	Leaks, bulges, signs of aging	Replace capacitor.
	Loose mounting bracket	Tighten nuts or screws holding bracket.
Switch contacts	Dirt, dust, and/or corrosion	Clean with cloth, aerosol spray, syringe or camelhair brush using trichloroethylene or equivalent.
	Bent or broken contacts	Replace switch wafer or assembly.
Transistors	Looseness	Tighten clips and tension leads, where applicable.

4-9. MINIMUM PERFORMANCE STANDARDS.

4-10. The minimum performance standards checks listed in table 4-3 provide a rapid, convenient means of ascertaining proper Main Frame operation. These checks are performed with the Main Frame operating in a Model SSB-50 Single Sideband Analyzer System. The quality of these checks presupposes that all plug-in units installed in the Main Frame are operating properly. Figure 4-3 illustrates the equipment setup required to perform the minimum performance checks. Before performing these checks, set the Main Frame POWER switch to OFF.

4-11. SYSTEMATIC TROUBLE LOCALIZATION.

4-12. Three possible troubles are presented in table 4-4 to illustrate a systematic approach to the isolation of trouble within the Main Frame. This procedure is performed with the Main Frame connected to a TTG-3 via the service cable and with the RF-8 and REC-2 installed. Note that full use is made of the maintenance information in the manual (e.g., voltage chart and schematic diagram). See figure 4-1 for the location of the referenced test points.

4-13. The three possible problems that will be considered are:

a. Neither +15 nor -15 volt outputs are obtainable.

b. +15 volt output is obtained but -15 volt output cannot be obtained.

c. -15 volt output is obtained but +15 volt output cannot be obtained.

4-14. SETTING +15—VOLT OUTPUT.

4-15. To set the +15-volt output level, proceed as directed in the following steps.

a. With the TTG-3 connected to the Main Frame via the service cable, connect a digital vtvm between +15V test point TP1 (red) and chassis ground.

b. Set the Main Frame POWER switch to ON and, after a few minutes warmup, adjust potentiometer A1R9 to obtain a digital vtvm indication of 15.00 volts.

c. Disconnect the digital vtvm.

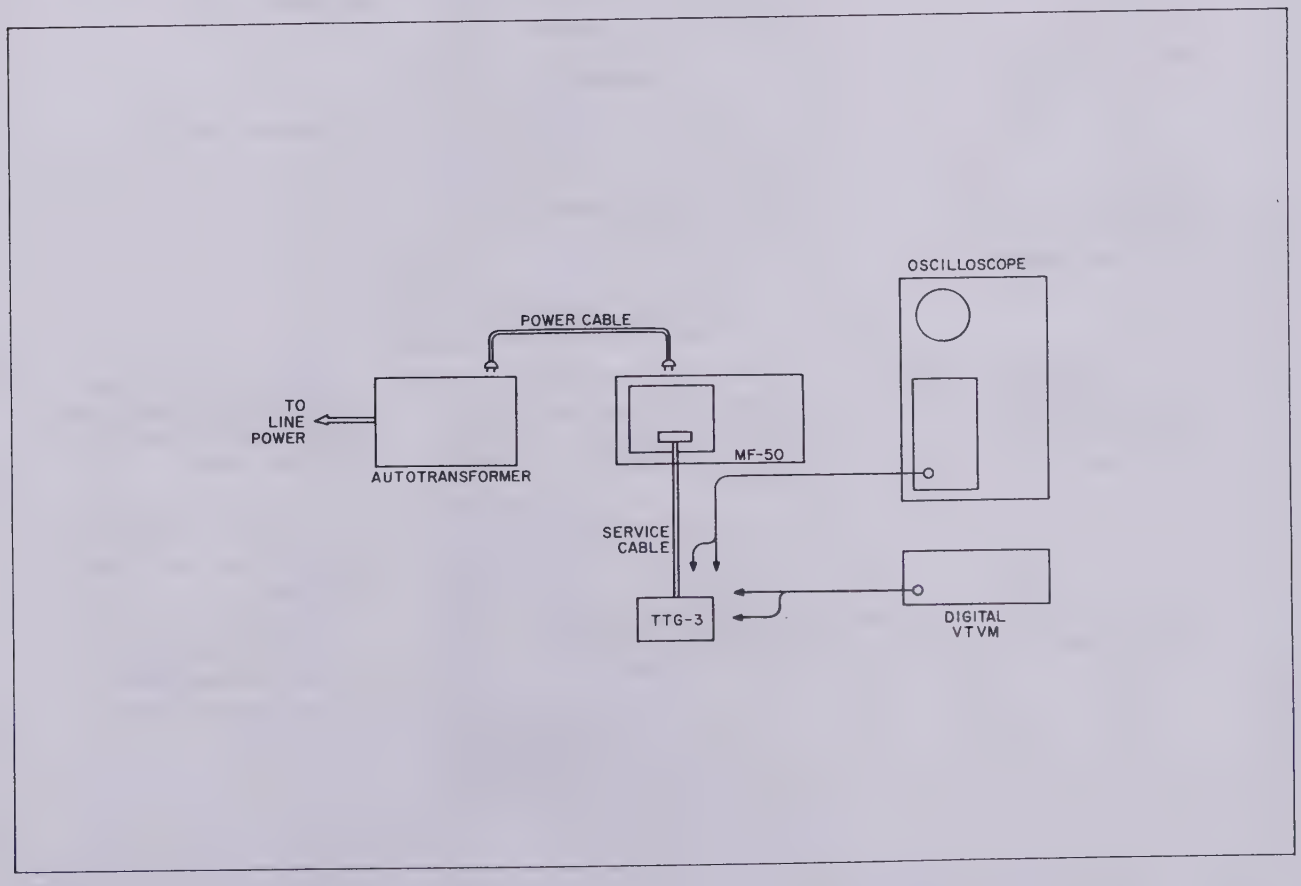


Figure 4-3. Minimum Performance Standards, Test Setup

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS

Step	Purpose	Procedure	Acceptable Indication
1	To evaluate +15 volt output.	a. Withdraw the TTG-3 from the Main Frame and interconnect the two by means of the service cable. Connect both a digital vtvm and an a-c coupled oscilloscope between +15V test point TP1 (red) and chassis ground.	
		b. Adjust the autotransformer for nominal line voltage and set the Main Frame POWER switch to ON; the POWER pilot lamp should illuminate. Adjust the autotransformer, if necessary, to maintain the nominal line voltage.	b. POWER pilot lamp illuminates upon application of line power.
		c. Note both the digital vtvm indication and the ripple content displayed on the oscilloscope.	c. Digital vtvm indicates +15 volts (±0. 20 volts); ripple voltage does not exceed 0. 010 volts peak to peak.
		d. Adjust the autotransformer to obtain a line voltage of 95 volts (if nominal is 115 volts) or 190 volts (if nominal is 230 volts) and again note the digital vtvm indication.	d. Digital vtvm indication does not change more than ±10 millivolts.
		e. Adjust the autotransformer to obtain a line voltage of 130 volts (if nominal is 115 volts) or 260 volts (if nominal is 230 volts) and again note the digital vtvm indication.	e. Same as step d.
		f. Adjust the autotransformer for nominal line voltage.	
2	To evaluate -15 volt output.	a. Connect both the digital vtvm and the a-c coupled oscilloscope between -15V test point TP2 (white) and chassis ground.	a. Digital vtvm indicates -15 volts (±0. 20 volts); ripple voltage does not exceed 0. 010 volts peak to peak.
		b. Adjust the autotransformer to obtain a line voltage of 95 volts (if nominal is 115 volts) or 190 volts (if nominal is 230 volts) and again note the digital vtvm indication.	b. Digital vtvm indication does not change more than ±10 millivolts.
		c. Adjust the autotransformer to obtain a line voltage of 130 volts (if nominal is 115 volts) or 230 volts (if nominal is 230 volts) and again note the digital vtvm indication.	c. Same as step b.

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
2 (Cont'd)		d. Set the POWER switch to OFF, remove the test equipment and insert the TTG-3 into the Main Frame.	

TABLE 4-4. SYSTEMATIC TROUBLE LOCALIZATION

No.	Symptom	Test Procedure	If Indication Is Normal	If Indication Is Abnormal
1	Neither +15 nor -15 volt outputs are obtainable.	a. Check fuses F1 and F2.	a. Replace fuses and go to step b.	a. Replace defective fuse with spare provided.
		b. Connect a vtvm between terminals 7 and 6 of T1. Note the vtvm indication; it should read approximately 32 volts.	b. Go to step c.	b. Replace defective transformer.
		c. Connect the vtvm between terminals 5 and 6 of T1. Note the vtvm indication; it should read approximately 32 volts.	c. Go to step d.	c. Replace defective transformer.
		d. Connect the vtvm between the junction of A1R2 and A1R3 and chassis ground. Note the vtvm indication; it should read approximately +35 volts.	d. Go to step e.	d. Check A1CR1 through A1CR4 and associated circuitry.
		e. Connect the vtvm between the junction of A1R12 and A1R13 and chassis ground. Note the vtvm indication; it should read approximately -35 volts.		e. Check A1CR1 through A1CR4 and associated circuitry.
2	+15 volt output is obtained but -15 volt output cannot be obtained.	Connect a digital vtvm between -15V test point TP2 (white) and chassis ground. Adjust potentiometer A1R19 to obtain a digital vtvm indication of -15.00 volts.	Digital vtvm indicates -15.00 volts.	Check Q2 and A1Q4 through A1Q6.

(Cont'd)

TABLE 4-4. SYSTEMATIC TROUBLE LOCALIZATION (Cont'd)

No.	Symptom	Test Procedure	If Indication Is Normal	If Indication Is Abnormal
3	-15 volt output is obtained but +15 volt output cannot be obtained.	Connect a digital vtvm between +15V test point TP1 (red) and chassis ground. Adjust potentiometer A1R9 to obtain a digital vtvm indication of +15.00 volts.	Digital vtvm indicates +15.00 volts.	Check Q1 and A1Q1 through A1Q3.

4-16. SETTING -15—VOLT OUTPUT.

4-17. To set the -15-volt output level, proceed as directed below.

a. With the TTG-3 connected to the Main Frame via the supplied service cable, connect a digital vtvm between -15V test point TP2 (white) and chassis ground.

b. Set the Main Frame POWER switch to ON and, after a few minutes warmup, adjust potentiometer A1R19 to obtain a digital vtvm indication of -15.00 volts.

c. Disconnect the vtvm.

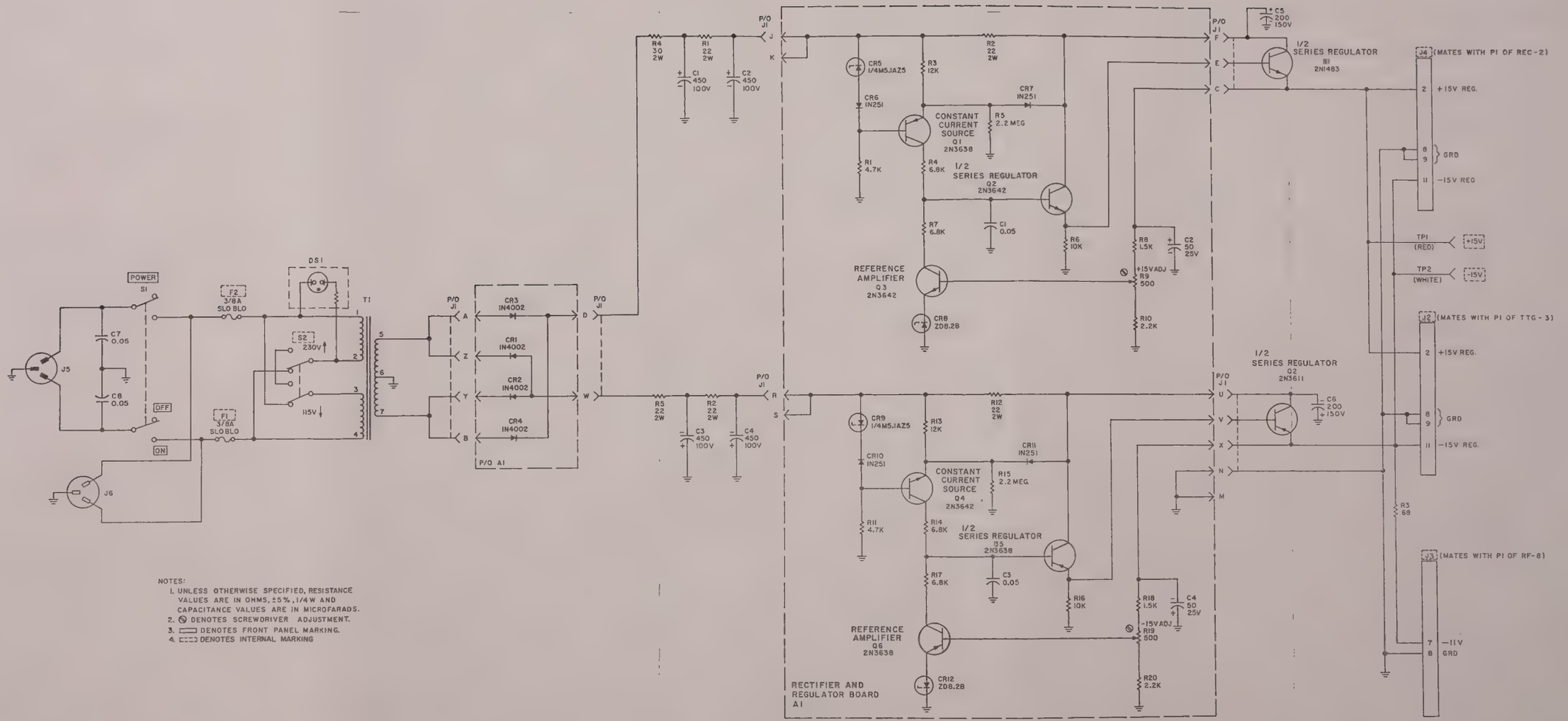
4-18. VOLTAGE MEASUREMENTS.

4-19. Voltage measurements for each of the stages in the Main Frame are given in table 4-5. These voltages were obtained under full load conditions, using an RCA WV-98C VTVM.

TABLE 4-5. VOLTAGE MEASUREMENTS, REGULATOR BOARD A1

Reference Designation	Transistor Type	Terminal Voltage		
		Base	Emitter	Collector
Q1	2N1483	+15.6	+15.0	+34
Q2	2N3611	-15.3	-15.0	-32
A1Q1	2N3638	+30.5	+31	+19
A1Q2	2N3642	+16	+15.6	+34
A1Q3	2N3642	+8.4	+ 7.8	+13.5
A1Q4	2N3642	-29.5	-30	-18
A1Q5	2N3638	-15	-15.3	-32
A1Q6	2N3638	-8.4	- 7.8	-13

SECTION V
SCHEMATIC DIAGRAMS



NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTANCE VALUES ARE IN OHMS, ±5%, 1/4W AND CAPACITANCE VALUES ARE IN MICROFARADS.
2. ⊘ DENOTES SCREWDRIVER ADJUSTMENT.
3. ▭ DENOTES FRONT PANEL MARKING.
4. ▭ DENOTES INTERNAL MARKING

Figure 5-1. Schematic Diagram, Main Frame

SECTION VI
PARTS LIST

6-1. INTRODUCTION.

6-2. This parts list section includes all pertinent data necessary to locate, identify, and procure additional parts for the equipment. Parts are listed alpha-numerically by reference symbol and include all replaceable items such as electronic, electro-mechanical, and mechanical parts of the equipment. In some cases, values, ratings and manufacturer sources shown are nominal and variations may be found. Satisfactory replacement may be made with either the listed component or an exact replacement of the part(s) removed from the equipment.

6-3. ORDERING INFORMATION.

6-4. The following instructions will aid in ordering parts from the Parts Lists, table 6-2.

a. Address all inquiries or orders to:

CUSTOMER SERVICE
Department 500-1
The Singer Company
Metrics Division
915 Pembroke Street
Bridgeport, Connecticut 06608

b. Include the following information:

1) Model and Serial Number of instrument.
2) Singer Part Number.
3) Reference Symbol Number.
4) Description (as shown on list).

6-5. HOW TO USE THE PARTS LIST.

6-6. Paragraphs 6-7 through 6-11 describe the use and meaning of the five columns included in the parts list (see figure 6-1).

6-7. REF SYMBOL COLUMN. The Ref Symbol Column (1, figure 6-1) contains an alpha-numerical listing of parts as they appear on equipment chassis, illustration, or schematic. The reference designation identifies the parts as to their component function in the instrument.

6-8. DESCRIPTION COLUMN. The Description Column (2, figure 6-1) contains the identification of component parts including all pertinent specifications and Singer part number. When the description column is used for a part which is identical to a part which has already been described; SAME AS (3) is used along with the reference symbol of the previously used part. In these instances, columns 3, 4, 5 are left blank. When the description column is used for a reference symbol for which no part exists; NOT USED (4) is placed in the column. In these instances, columns 3, 4, 5, are left blank.

6-9. MANUFACTURER'S PART NUMBER COLUMN. The Manufacturer's Part Number column (5, figure 6-1) contains the part number as designated by the manufacturer of the part.

6-10. MFR'S CODE COLUMN. The Mfr's Code column (6, figure 6-1) references the manufacturer by an assigned code number as listed in Federal Supply Code Handbook H4-2. For manufacturers not listed in H4-2, a letter code will be assigned. Table 6-1 includes the manufacturer and his code designation.

6-11. MAINT QTY COLUMN. The Maint Qty column (7, figure 6-1) contains the number of additional components recommended to keep the equipment at an optimum performance level. The recommended number of components in the Maint Qty column is based on 2000 hours of equipment operation.

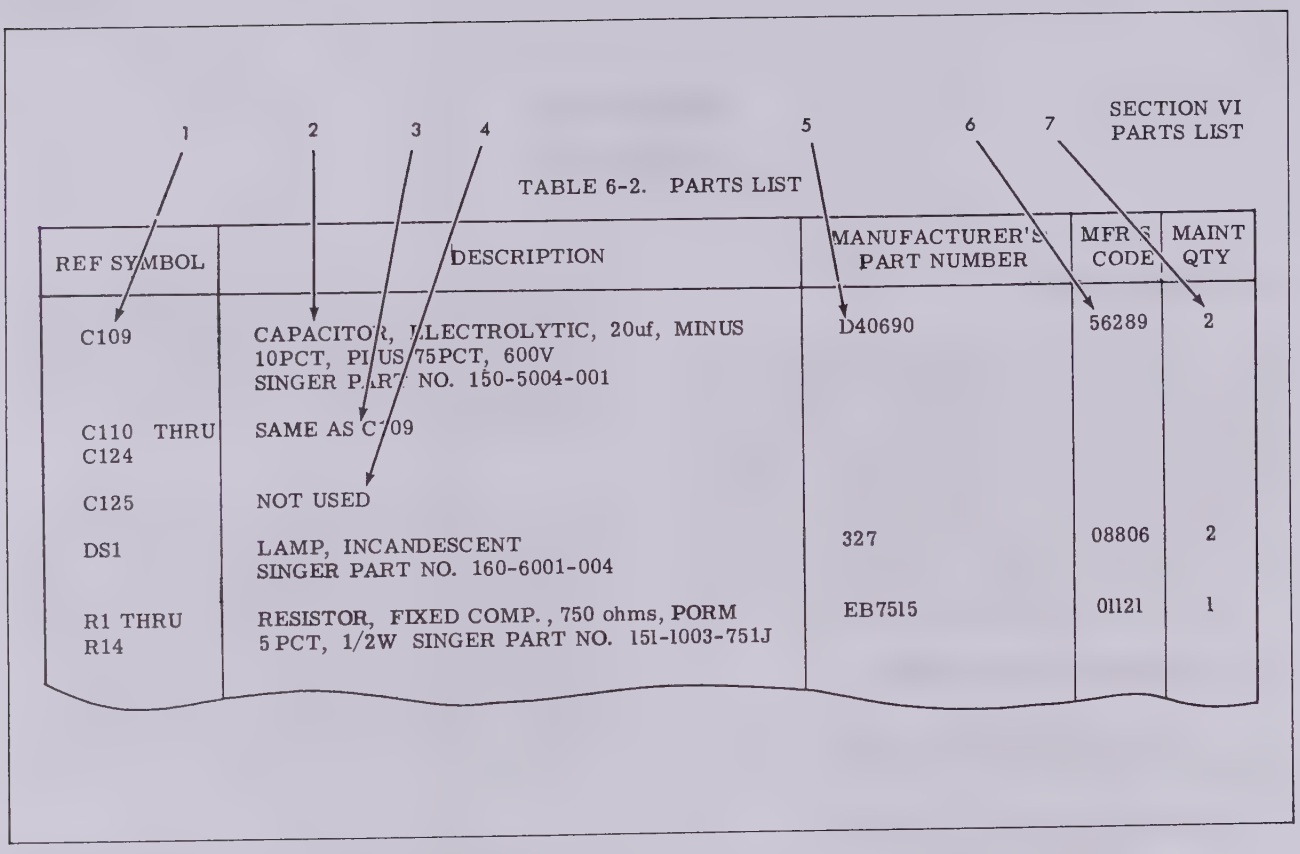


Figure 6-1. Parts List Sample

TABLE 6-1. MANUFACTURER'S CODE

Number	Name
01121	Allen-Bradley Co., Milwaukee, Wisc.
02660	Amphenol-Borg Electronics Corp., Maywood, Ill.
04713	Motorola Inc., Semiconductor Products Division, Pheonix, Ariz.
09023	Cornell-Dubilier Electric Corp., Electrolytics and Paper Tubular Division, Sanford, N.C.
12060	Diodes Inc., Chatsworth, Calif.
16665	The Singer Co., Metrics Division Bridgeport, Conn.
56289	Sprague Electric Co., North Adams, Mass.
71400	Bussmann Mfg. Division of McGraw Edison Co., St. Louis, Mo.
71450	CTC Corp., Elkhart, Ind.
71590	Centralab Division of Globe-Union Inc., Milwaukee, Wisc.
74545	Harvey Hubbell Inc., Bridgeport, Conn.
75915	Littelfuse Inc., Des Plaines, Ill.
81349	Military Specifications
82389	Switchcraft Inc., Chicago, Ill.
90201	P.R. Mallory and Co., Inc. Detroit, Mich.
91802	Industrial Devices Inc., Edgewater, N.J.
95354	Methode Mfg. Co., Chicago, Ill.
98291	Sealectro Corp., Mamaroneck, N.Y.

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
C1 THRU C4	CAPACITOR,FIXED,ELECTROLYTIC, 450 UF, 100V SINGER PART NO. 556146-592	36D451F100AA6C	56289	2
C5 AND C6	CAPACITOR,FIXED,ELECTROLYTIC, 200 UF,PLUS 100 PCT,MINUS 10 PCT,150V SINGER PART NO. 556146-690	BR-200-150	09023	1
C7 AND C8	CAPACITOR,FIXED,CERAMIC DISC, 0.05 UF,1000V SINGER PART NO. 556074-058	DA136-039CB	71590	1
DS1	LAMP,PILOT,NEON WHITE SINGER PART NO. 160-6006-004	2110A4	91802	4
F1 AND F2	FUSE, 3/8 AMP, SLOW BLOW SINGER PART NO. 556006-008	MDL318	71400	5
J1	CONNECTOR,JACK SINGER PART NO. 168-3002-007	71-6022-1100-00	95354	1
J2 THRU J4	CONNECTOR,JACK SINGER PART NO. 556166-046	26-190-16	02660	1
J5	CONNECTOR,AC MALE SINGER PART NO. 556010-003	7486	74545	1
J6	CONNECTOR,AC FEMALE SINGER PART NO. 556010-042	7487	74545	1
Q1	TRANSISTOR SINGER PART NO. 556146-012	2N1483	81349	1
Q2	TRANSISTOR SINGER PART NO. 556146-391	2N3611	81349	1
R1 AND R2	RESISTOR,FIXED,COMP., 22 OHMS,PORM 5 PCT,2W SINGER PART NO. 151-1005-220J	HB2205	01121	2
R3	RESISTOR,FIXED,COMP., 68 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-680J	EB6805	01121	1
R4	RESISTOR,FIXED,COMP., 30 OHMS,PORM 5 PCT,2W SINGER PART NO. 151-1005-270J	HB3005	01121	1
R5	SAME AS R1			
S1	SWITCH,POWER	133-0069-001	16665	1
S2	SWITCH,SLIDE,DPDT SINGER PART NO. 556146-590	46206LF	82389	1
TP1	JACK,TIP SINGER PART NO. 556024-084	SKT-8RED	98291	1
TP2	JACK,TIP SINGER PART NO. 556024-085	SKT-8WHT	98291	1
T1	TRANSFORMER	132-0210-001	16665	1
W1	LINE CORD, A.C.	556161-066	16665	1
XF1 AND XF2	HOLDER,FUSE SINGER PART NO. 556006-015	342004	75915	1
XQ2	SOCKET,TRANSISTOR SINGER PART NO. 556024-163	MK-15	04713	1
A1	RECTIFIER AND REGULATOR ASSY	103-1522-001	16665	1
A1CR1 THRU A1CR4	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556118-176	IN4002	81349	1

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A1CR5	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556166-035	M5.1AZ5	04713	1
A1CR6 AND A1CR7	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556118-046	IN251	81349	1
A1CR8	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556146-691	ZD8.2B	12060	1
A1CR9	SAME AS A1CR5			
A1CR10 AND A1CR11	SAME AS A1CR6			
A1CR12	SAME AS A1CR8			
A1C1	CAPACITOR,FIXED,CERAMIC DISC, 0.05 UF,PLUS 80 PCT,MINUS 20 PCT,200V SINGER PART NO. 556074-057	33C137	56289	1
A1C2	CAPACITOR,FIXED,ELECTROLYTIC, 50 UF, 25V SINGER PART NO. 150-5007-019	BR-50-25	09023	1
A1C3	SAME AS A1C1			
A1C4	SAME AS A1C2			
A1Q1	TRANSISTOR SINGER PART NO. 556146-255	2N3638	81349	1
A1Q2 THRU A1Q4	TRANSISTOR SINGER PART NO. 556146-702	2N3642	81349	1
A1Q5 AND A1Q6	SAME AS A1Q1			
A1R1	RESISTOR,FIXED,COMP., 4.7K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-472J	CB4725	01121	1
A1R2	SAME AS R1			
A1R3	RESISTOR,FIXED,COMP., 12K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-123J	CB1235	01121	1
A1R4	RESISTOR,FIXED,COMP., 6.8K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-682J	CB6825	01121	1
A1R5	RESISTOR,FIXED,COMP., 2.2MEGOHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-225J	CB2255	01121	1
A1R6	RESISTOR,FIXED,COMP., 10K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-103J	CB1035	01121	1
A1R7	SAME AS A1R4			
A1R8	RESISTOR,FIXED,COMP., 1.5K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-152J	CB1525	01121	1
A1R9	RESISTOR,VARIABLE, 500 OHMS SINGER PART NO. 556203-010	X201R501B	71450	1
A1R10	RESISTOR,FIXED,COMP., 2.2K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-222J	CB2225	01121	1
A1R11	SAME AS A1R1			
A1R12	SAME AS R1			

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A1R13	SAME AS A1R3			
A1R14	SAME AS A1R4			
A1R15	SAME AS A1R5			
A1R16	SAME AS A1R6			
A1R17	SAME AS A1R4			
A1R18	SAME AS A1R8			
A1R19	SAME AS A1R9			
A1R20	SAME AS A1R10			

INSTRUCTION MANUAL

MODEL RF-8 TUNING HEAD

AND

MODEL MF-8 MAIN FRAME

Serial No. _____

Instruction Manual No. 110-5028

SINGER
INSTRUMENTATION

THE SINGER COMPANY • INSTRUMENTATION DIVISION

Creative Products for Test, Measurement, Analysis, Calibration

ADDENDUM

for

MODEL RF-8

(Effective on Serial No. U12524 Thru U12623
and U16258 Thru U16307)

1. In figure 5-1, change A3C5 and C6 to 27pf.

2. Make the following changes to the List of Replaceable Parts.

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A3C5 AND C6	CAPACITOR, FIXED, DIPPED MICA, 27 PF, PORM 5 PCT, 500 V Singer P/N 150-2002-270CJO	DM15C270JO500 WV4CR	72136	1
A3C8 THRU A3C11	CAPACITOR, FIXED, DIPPED MICA, 22PF, PORM 5 PCT, 500 V Singer P/N 150-2002-220CJO	DM15C220JO500 WV4CR	72136	1
A3C16 AND A3C17	SAME AS A3C8			

ADDENDUM

for

TUNING HEAD MODEL RF-8

(Effective on the following units: Serial Numbers U30407; U30408; U30410; U30416; U30417; U30419; and all units with serial numbers above)

Make the following changes to the Model RF-8 Tuning Head Instruction Manual:

a. Make changes to Figure 5-1 as follows:

1. Change the value of capacitors A3C14 and A3C15 from 47 picofarads to 100 picofarads.

2. Change the value of capacitors A3C3 and A3C4 from 8±0.5pf to 15 pf, and designate as C3 15△ and C4 15△ .

3. Add Note 6 as follows: △ denotes factory select component.

4. Add resistor A3R30 (nominally 1K), designated R30 1K△, in parallel with capacitor A3C2.

5. Add capacitor A3C21 (0.01 microfarads) between board terminals 8 and 10.

6. Add capacitor A3C22 (0.01 microfarads) between board terminals 7 and 8.

7. Delete diodes A3CR2, A3CR5, A3CR8, A3CR11, A3CR14 and A3CR17.

b. In the Parts List, table 6-2, delete all reference to diodes A3CR2, A3CR5, A3CR8, A3CR11, A3CR14, and A3CR17, and make the following changes and additions.

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A3C3 and A3C4	CAPACITOR, NOMINALLY 15 PF, FACTORY SELECT			
A3C14 and A3C15	CAPACITOR, FIXED, DIPPED MICA, 100 PF, PORM 5 PCT, 500 V SINGER PART NO. 150-2002-101EJO	DM15E101JO 500WV4CR	72136	1
A3C21 and A3C22	SAME AS C101			
A3R30	RESISTOR, NOMINALLY 1K, FACTORY SELECT			

ADDENDUM

for

MODEL RF-8

I. PURPOSE:

To reflect change in output level specification.

II. ADDENDUM:

a. In table 1-1, change the output voltage level specification from "0.250 to 0.550 volt rms" to "0.200 to 0.550 volt rms."

b. In table 4-2, change the acceptable indication for step 1 from "...between 0.250 and..." to "...between 0.200 and..."

c. In table 4-3, change the normal indication for step 1 from "...amplitude from 0.250 to..." to "... amplitude from 0.200 to..."

Addendum No. 617

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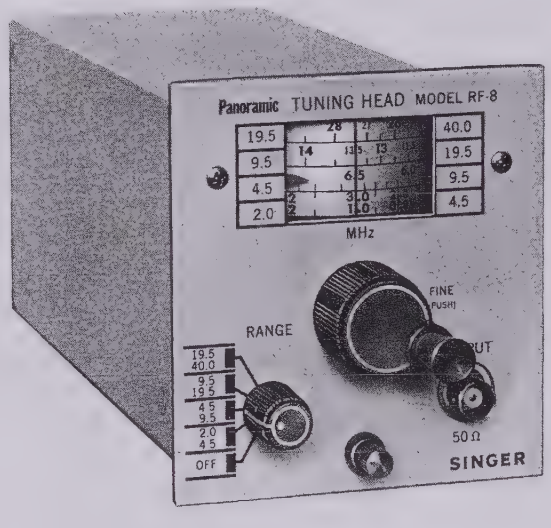
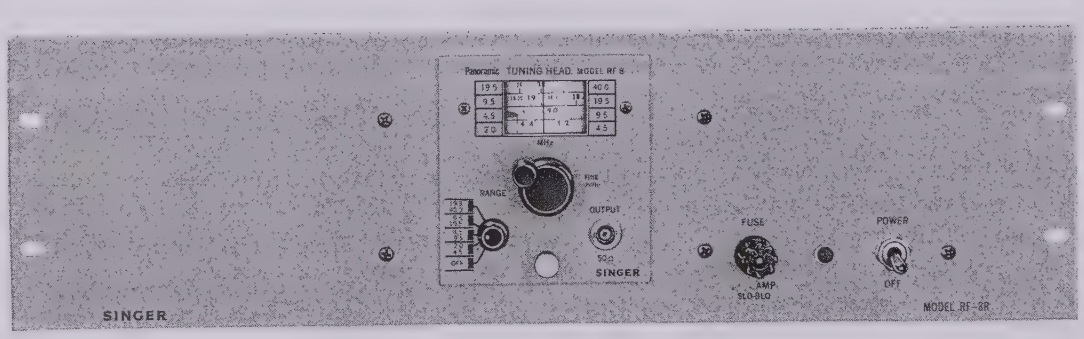


Model RF-8



Model RF-8 installed in MF-8 (RF-8R)

Figure 1-1. Tuning Head Model RF-8 and Rack Mounting Assembly Model MF-8

SECTION I

INTRODUCTION

1-1. SCOPE OF MANUAL.

1-2. This instruction manual provides operating and maintenance instructions for the PANORAMIC* Tuning Head, Model RF-8 (hereafter referred to as the Tuning Head) and the PANORAMIC Rack Mounting Assembly, Model MF-8 (hereafter referred to as the Rack Mounting Assembly) manufactured by The Singer Company, Metrics Division. (See figure 1-1.) The Tuning Head is a plug-in unit used with either Main Frame Models MF-2 and MF-50 or the Rack Mounting Assembly. The combination of a Tuning Head and Rack Mounting Assembly is referred to as the Model RF-8R.

1-3. The information contained in this manual refers only to the standard version of the Tuning Head and is current only to the date of publication. Differences in equipment components, specifications and performance resulting from The Singer Company's continuous production improvement program or individual customer design and application requirements are described in addendum sheets.

1-4. PURPOSE AND USE OF EQUIPMENT.

1-5. The Tuning Head is a transistorized VFO (variable frequency oscillator) primarily designed for use with the Model CA-5 Panalyzer in the PANORAMIC Model SSB-50 Single Sideband Spectrum Analyzer. The RF-8 and CA-5 provide r-f spectrum analysis in the frequency range from 2 to 40 MHz. When used with the Rack Mounting Assembly, the Tuning Head is a solid-state replacement for the Model RF-7a Tuning Unit in the PANORAMIC Models SSB-3b and SSB-4 Analyzer. The Rack Mounting Assembly provides the Tuning Head with the necessary mounting enclosure and operating power during rack-mount operation.

1-6. GENERAL DESCRIPTION.

1-7. The Tuning Head is a highly stable continuous tuning oscillator plug-in unit designed to provide injection signals over the frequency range from 2.5 to 40.5 MHz in four bands. (The frequency indicated by the Tuning Head dial is 500 kHz below the Tuning Head output.) It consists mainly of a precision inductance tuned variable frequency oscillator and frequency dividers, and is contained in a completely shielded enclosure. The oscillator frequency stability and low spurious radiation of the Tuning Head make it particularly suitable for use in single-sideband analysis.

1-8. The range of signal frequencies generated by the Tuning Head is divided into four bands. The RANGE selector switch and tuning control provide tuning over the 2 to 40 MHz frequency range. A two-speed tuning drive within the unit facilitates rapid frequency changes while retaining the slow, backlash-free tuning required for the final tuning of the Tuning Head. The output of the Tuning Head is available at a front-panel and a rear BNC connector. The Tuning Head requires an 11-volt regulated dc power source for operation. This voltage is supplied by either the MF-2, MF-50 or the Rack Mounting Assembly.

1-9. The Rack Mounting Assembly is a relay rack mounting unit designed for a standard 19-inch rack. It contains an 11-volt dc power supply which furnishes the Tuning Head with operating power. The Tuning Head fits into an opening in the Rack Mounting Assembly, connecting the Tuning Head to the d-c power source. The Rack Mounting Assembly operates from a 105 to 125 volt, 50 to 400 Hz, a-c power line.

1-10. SPECIFICATIONS.

1-11. Table 1-1 lists the electrical and physical characteristics of the Tuning Head and Rack Mounting Assembly.

1-12. TRANSISTOR, DIODE AND FUSE COMPLEMENT.

1-13. Table 1-2 lists the entire complement of transistors, diodes and fuses used in the Tuning Head and Rack Mounting Assembly.

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TABLE 1-1. SPECIFICATIONS

RF-8	
Output Frequency Range:	2.5 to 40.5 MHz minimum
Output Voltage Level:	0.250 to 0.550 volt rms
Output Impedance:	50 ohms
Frequency Modulation Hum:	0.5 Hz at 30MHz maximum
Spurious Signal Level:	-60 dB down from the output level (except those harmonically related).
Operating Voltage Required:	11 ± 0.1 volts dc at 60 ma
Operating Temperature Range:	0 to 55° Centigrade
Physical Characteristics:	
Weight:	3 lbs
Width:	3-3/4 inches
Height:	4 inches
Depth (including handle):	11-3/4 inches
MF-8	
Output Voltage:	11 volts dc at 0.2 amp.
Operating Voltage Required:	105 to 125 volts ac, at 50 to 400Hz
Power Consumption:	4 watts
Operating Temperature Range:	0 to 55° Centigrade
Physical Characteristics:	
Weight:	5 lbs
Width:	19 inches
Height:	5-1/4 inches
Depth:	11-1/4 inches

TABLE 1-2. TRANSISTOR, DIODE AND FUSE COMPLEMENT

Ref. Desig.	Type	Function
	RF-8	
A1Q1	2N3646	Colpitts Oscillator
A2Q1	2N3646	Grounded-Base Amplifier
A2Q2	2N3646	Emitter Follower
A3Q1 and Q2	2N3646	Flip-Flop
A3Q3 and Q4	2N3646	Flip-Flop
A3Q5 and Q6	2N3646	Flip-Flop
A3Q7	2N3567	Filter
A3CR1-CR18	1N995	Flip-Flop Diodes
	MF-8	
F1	1/10 Amp SLO-BLO	A-c Line Protection

SECTION II

OPERATION

2-1. GENERAL.

2-2. This section contains installation and operating instructions for the Tuning Head and Rack Mounting Assembly. The Tuning Head has been factory tested and aligned and is shipped in a ready-to-operate condition. However, no attempt should be made to install or operate the unit until the operator is thoroughly familiar with the contents of this section. Figures 2-1 and 2-2 are outline dimension drawings of the Rack Mounting Assembly and Tuning Head, respectively.

2-3. INSTALLATION.

2-4. To install the Rack Mounting Assembly in a standard 19-inch relay rack, place the assembly in the position desired and secure the front panel to the vertical members of the rack with four screws. After the Rack Mounting Assembly is installed, connect the power cord to a source of 105 to 125 vac, 50 to 400 Hz power.

2-5. To install a Tuning Head in the Rack Mounting Assembly, install the Tuning Head in the cavity, and firmly seat the Tuning Head in place. If any resistance is noted while inserting the Tuning Head, withdraw it and examine the connectors on the rear of the Tuning Head and the rear wall of the Rack Mounting Assembly cavity for proper alignment. Tighten the front-panel fastener on the Tuning Head to mechanically secure it to the Rack Mounting Assembly. The procedure for installing a Tuning Head in the Models MF-2 and MF-50 Main Frames is identical.

2-6. OPERATION.

2-7. OPERATING CONTROLS, INDICATORS, AND CONNECTORS. The operating controls, indicators, and connectors for the Tuning Head and Rack Mounting Assembly are described in table 2-1 and shown in figure 2-3.

2-8. OPERATING PROCEDURE. The following procedure describes how to operate the Tuning Head. The procedure assumes that power is applied to the unit.

a. Set the RANGE switch to the desired frequency range.

b. Rotate the tuning control until the desired frequency marking of the tuning dial MHz is aligned with the graticule.

TABLE 2-1. OPERATING CONTROLS, INDICATORS AND CONNECTORS

Index No. (Figure 2-3)	Reference Designation	Name	Function
		RF-8	
6	S1	RANGE	Selects desired output frequency range from 2.5 to 4.5 MHz, 4.5 to 9.5 MHz, 9.5 to 19.5 MHz and 19.5 to 40.5 MHz.
2		Tuning Control	Selects desired output frequency within selected range. A FINE tuning feature is selected by pressing in the tuning control. The entire selected frequency range is covered by 24 turns of the control or 384 turns of the control in the FINE mode.
1		Tuning Dial, MHz	Indicates the analyzer input frequency to be heterodyned with the selected output frequency. The output frequency is actually 500 kHz above the value indicated on the tuning dial. The yellow band

(Cont'd)

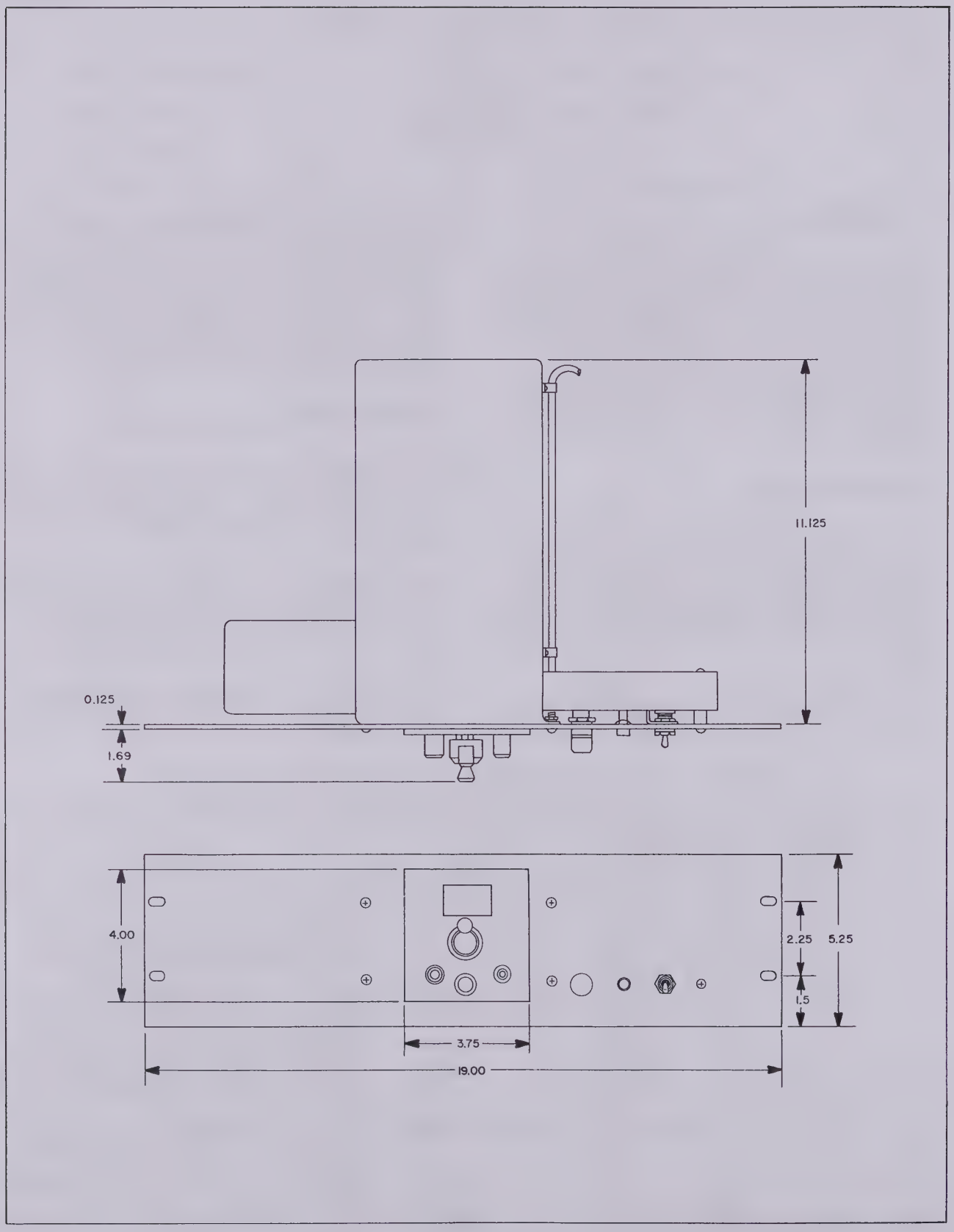


Figure 2-1. Outline Dimension Drawing, Rack Mounting Assembly (With Tuning Head Installed)

TABLE 2-1. OPERATING CONTROLS, INDICATORS AND CONNECTORS (Cont'd)

Index No. (Figure 2-3)	Reference Designation	Name	Function
1 (Cont'd)			(calibrated from 0 to 2 MHz) on the 2.0 to 4.5 MHz portion of the MHz tuning dial is for use with the Model REC-2 Range Extending Converter. Refer to the REC-2 manual.
3	P1	OUTPUT 50 Ω	Provides the unit output to a BNC connector. A second output is available at the rear of the unit.
4	S1	MF-8 POWER	Applies primary power to the Rack Mounting Assembly.
5	DS1	Power Indicator Light	Illuminates to indicate that power is applied to the Rack Mounting Assembly.

2-9. PACKAGING INSTRUCTIONS.

2-10. The following packaging instructions provide information for short term and long term storage and shipping of the Tuning Head and Rack Mounting Assembly.

2-11. SHORT-TERM PACKAGING. For short-term packaging, the Tuning Head or Rack Mounting Assembly should be enclosed in a polyethylene bag and placed in a suitable carton for protection. The carton should be stored in a clean and moisture-free area. All accessories and literature should be securely fastened to the equipment in order to prevent loss.

2-12. LONG-TERM PACKAGING AND PACKAGING FOR SHIPMENT. Figure 2-4 and 2-5 illustrate the packaging procedure for the Tuning Head and Rack Mounting Assembly, respectively.

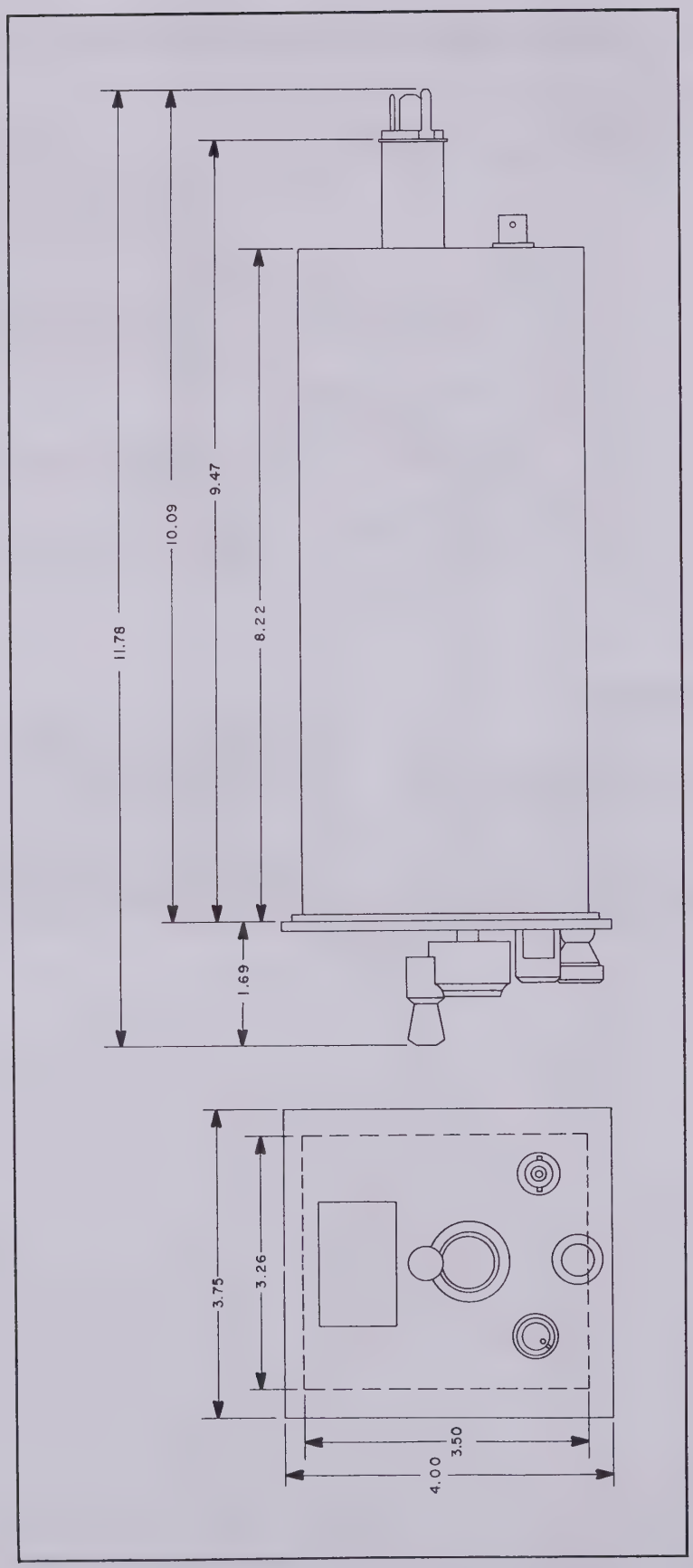


Figure 2-2. Outline Dimension Drawing, Tuning Head

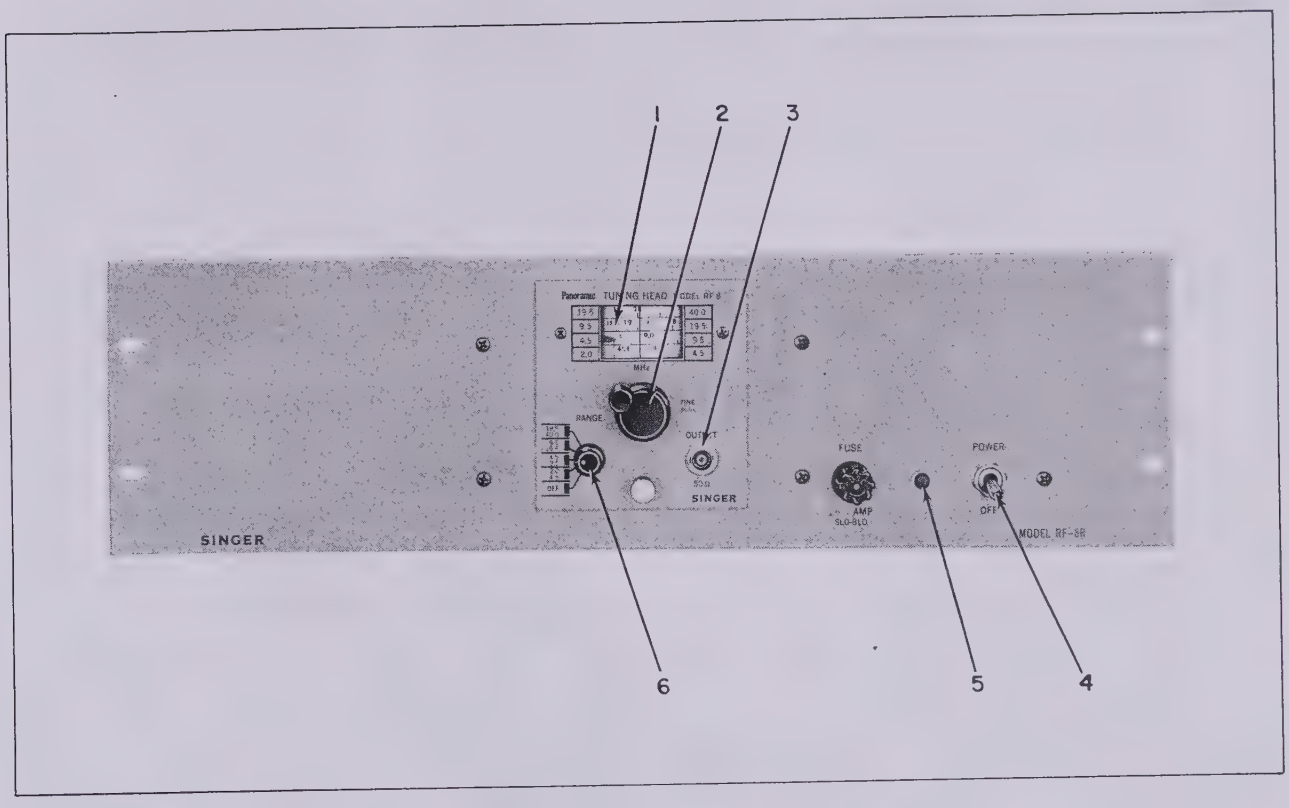


Figure 2-3. Tuning Head and Rack Mounting Assembly, Operating Controls, Indicators, and Connectors

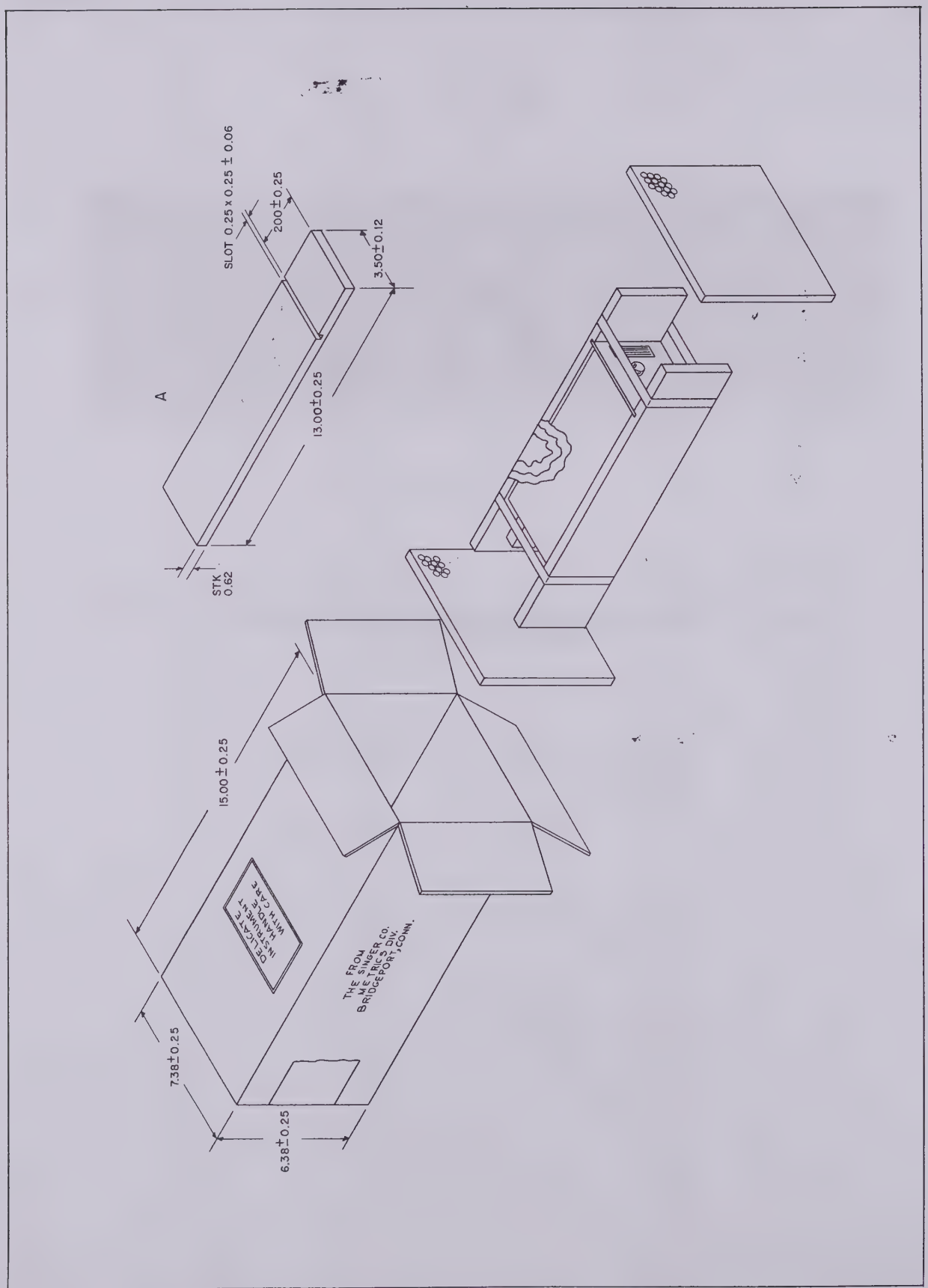


Figure 2-4. Packaging the Tuning Head

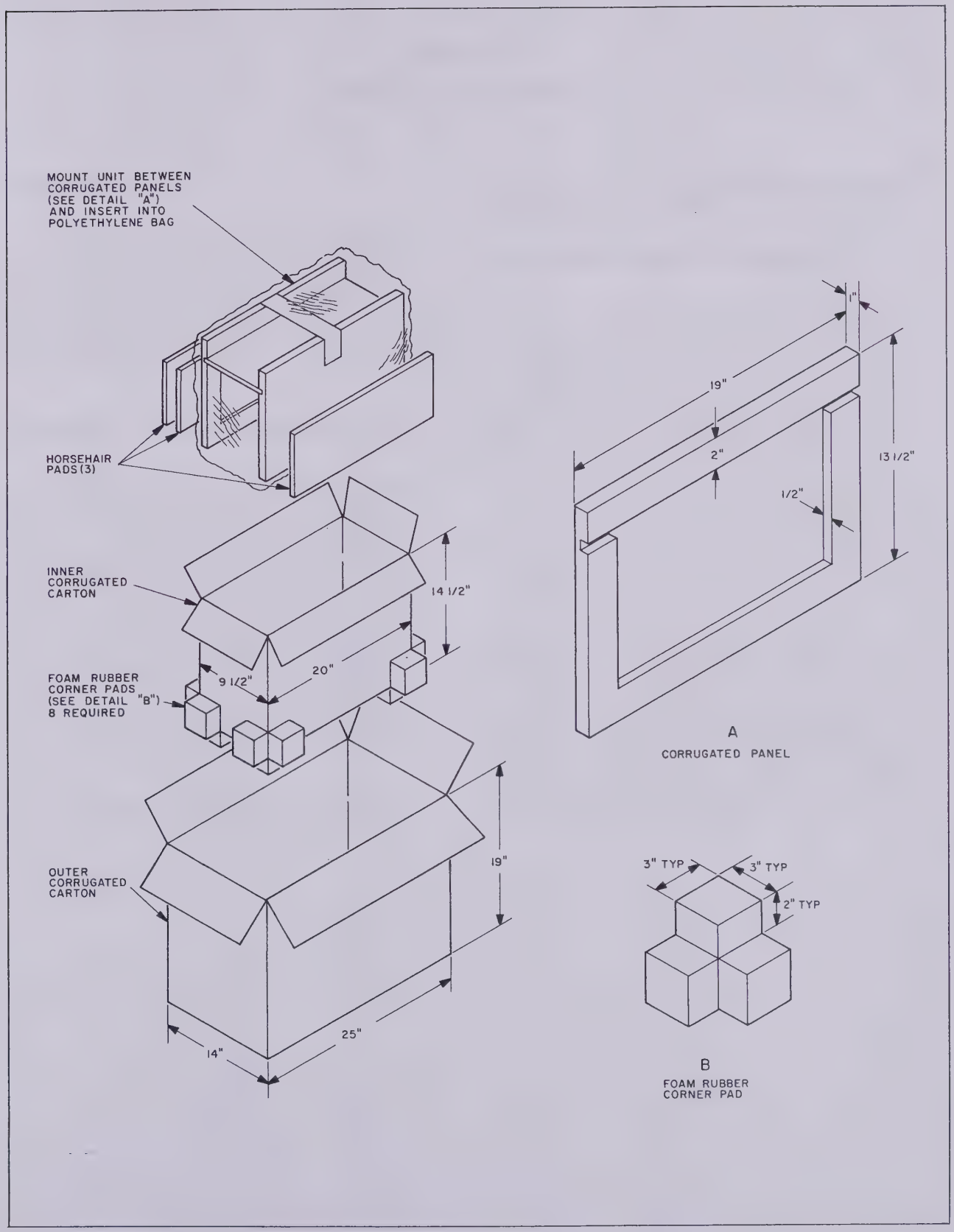


Figure 2-5. Packaging the Rack Mounting Assembly

SECTION III

THEORY OF OPERATION

3-1. GENERAL.

3-2. This section contains the theory of operation for the Tuning Head and Rack Mounting Assembly. The Tuning Head is basically a tunable oscillator-divider unit that provides injection signals in the frequency range from 2.5 to 40.5 MHz. Operating power for the Tuning Head is provided by either the Models MF-2 and MF-50 Main Frames or the Rack Mounting Assembly.

3-3. SIMPLIFIED BLOCK DIAGRAM ANALYSIS.

3-4. The Tuning Head (figure 3-1) contains a tunable oscillator that is inductively tuned over a frequency range of 20 to 40.5 MHz by the front panel tuning control. (Tuning Head dial indication is 500 kHz below the oscillator frequency.) The oscillator output is then amplified before being applied to a three stage flip-flop frequency divider and the OUTPUT 50Ω connector (when RANGE switch S1 is in the 19.5-40.0 position). Within the frequency divider the oscillator output frequency (20 to 40.5 MHz) is divided by 1/2, 1/4, and 1/8, providing an output in the frequency ranges of 10 to 20 MHz, 5 to 10 MHz and 2.5 to 5 MHz, respectively, for the 9.5-19.5, 4.5-9.5 and 2.0-4.5 positions of RANGE switch S1. A filter is provided in the Tuning Head to provide a filtered d-c voltage to the oscillator.

3-5. The Rack Mounting Assembly consists of an 11-volt regulated dc power supply and related circuity. The power supply furnishes the Tuning Head with the necessary operating voltage.

3-6. DETAILED THEORY OF OPERATION.

3-7. The Tuning Head (figure 5-1) consists of three major electronic assemblies: The Oscillator (A1), the Amplifier (A2) and the Divider/Regulator (A3). The oscillator is of the Colpitt-Clapp type and is inductively tuned by inductuner L2, which is mechanically ganged to the front panel tuning control. The amplifier consists of grounded-base buffer amplifier A2Q1 and emitter follower A2Q2. The oscillator output applied directly to RANGE switch S1 is taken from a point in the emitter circuit of A2Q2 which provides correct output impedance of 50 ohms. The oscillator output applied to the frequency divider is provided at a lower output impedance. The divider consists of three conventional flip-flops. Stage A3Q7 provides cancellation of power supply ripple and transients.

3-8. The Rack Mounting Assembly (figure 5-2) consists of the 11-volt dc regulated power supply and associated input circuitry. When POWER switch S1 is placed to the up (on) position, the 105 to 125-volt a-c input is applied to the 11-volt dc power supply, resulting in the supply output of 11 volts dc. The 11-volt dc supply voltage is coupled to the Tuning Head via pins 7 and 8 of connector J1. Fuse F1 protects the circuitry of the power supply, and indicator DS1 illuminates when a-c power is energizing the unit.

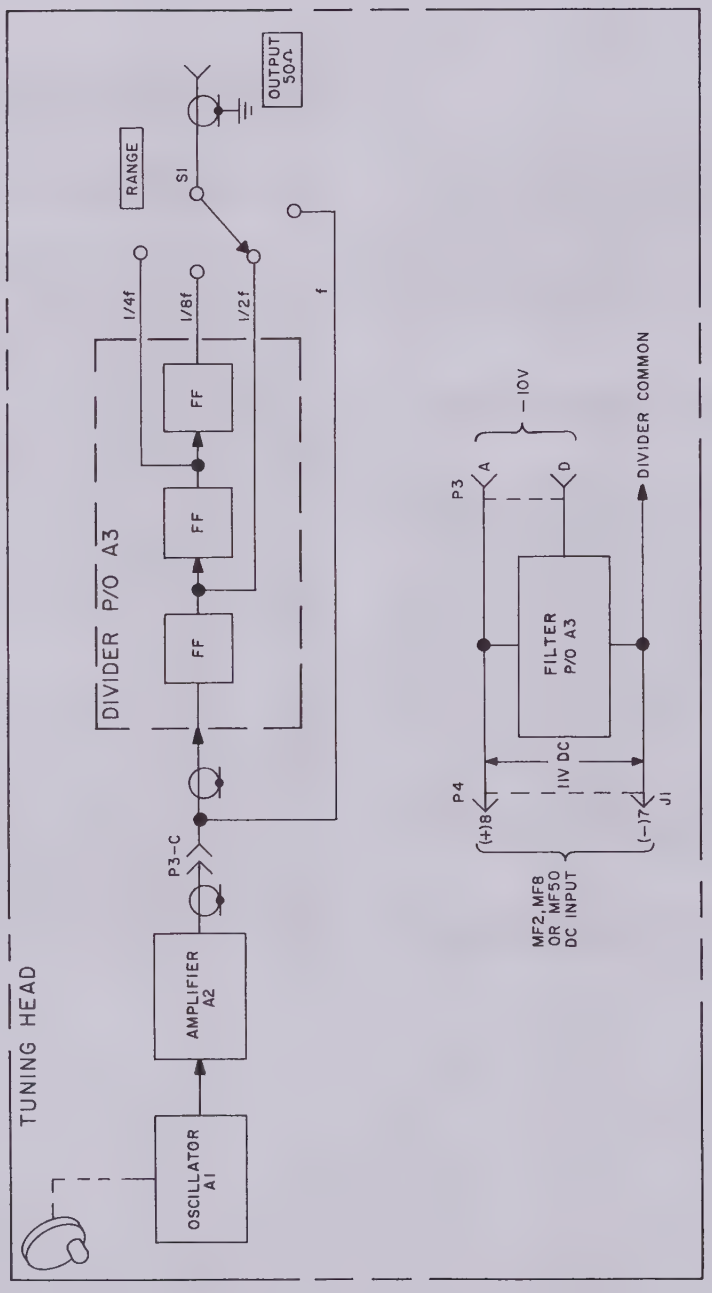


Figure 3-1. Tuning Head and Rack Mounting Assembly, Simplified Block Diagram

SECTION IV

MAINTENANCE

4-1. GENERAL.

4-2. This section contains maintenance instructions for the Tuning Head. No attempt should be made to repair internal components or make any adjustments until the operator is thoroughly familiar with the information contained in this section. No maintenance is required of the Rack Mounting Assembly other than keeping it clean and dry. If the 1/32 ampere fuse on the assembly blows, examine the unit for possible short circuits. Never replace the fuse with one of a higher rating.

4-3. The performance of the Tuning Head may be checked using the minimum performance standards checks provided in this section to determine whether the equipment is operating within the specified tolerances. A systematic trouble shooting procedure is presented to provide a guide line to isolating troubles in the Tuning Head. The applications of maintenance data is shown by means of examples used in the body of the trouble shooting procedure.

4-4. Despite its simplicity of operation, the Tuning Head is a complex electronic device. While equipment components have been carefully selected for reliability, some degradation of component characteristics and occasional failure of parts due to aging is possible. As with all high-frequency equipment of this type, the installation and adjustment of many internal components is highly critical, and repair or replacement of certain parts may entail extensive realignment.

4-5. These maintenance procedures require trained maintenance personnel with a high degree of specialized knowledge and experience in servicing equipment of this type. If trouble develops which cannot be corrected by the procedures described in the following paragraphs, contact the Service Department, Singer Co., Metrics Division, Bridgeport, Connecticut. If epoxied components of the Tuning Head require replacement, it is strongly recommended that the instrument be returned to the Service Department of The Singer Company.

4-6. TEST EQUIPMENT REQUIRED.

4-7. Table 4-1 lists the recommended test equipment required for the alignment and test procedures given in this section.

4-8. PRELIMINARY INSPECTION.

4-9. COMPONENT LOCATION. The location of components mentioned in the inspection routines, performance standards, trouble localization and alignment are illustrated in figures 4-1 through 4-3.

4-10. INSPECTION ROUTINES. To perform a preliminary inspection of the Tuning Head, proceed as follows:

a. Remove the top cover of the Tuning Head.

b. Inspect the components in the Tuning Head for signs of overheating and for loose or broken connections.

c. Inspect the knobs, control shafts and couplings for tightness; examine switch contacts for signs of corrosion, pitting or burning.

4-11. MINIMUM PERFORMANCE STANDARDS.

4-12. The Minimum Performance Standards Checks, described in table 4-2, are designed to completely check out the Tuning Head and determine that it meets all rated specifications. In order to make these checks, the Tuning Head must be energized by its source of d-c power.

4-13. Perform each step in table 4-2 in the order listed. Note any deviation from the acceptable indications, and refer to table 4-3 Systematic Trouble Localization and to the alignment procedures for corrective action.

4-14. POWER SUPPLY CHECK.

4-15. Before proceeding with systematic trouble-shooting of the Tuning Head, the d-c input voltage and the regulator output voltage should be checked. This check will usually determine whether abnormal d-c voltages are causing the malfunction.

4-16. Check the d-c input to the Tuning Head with the VTVM. The voltage should be 11 volts dc. If this voltage is incorrect when using the Tuning Head with the Rack Mounting Assembly, adjust the 11-volt dc supply output control (figure 4-3) on the Rack Mounting Assembly for the proper indication. If the voltage is correct, remove the Tuning Head from the main frame or Rack Mounting Assembly and connect d-c power to it using the 16-connector service cable provided with the main frame and Rack Mounting Assembly. Remove the top cover and use the VTVM to measure the voltage between terminals A3-7 (negative) and A3-10 (positive). This voltage must be between 0.25 and 1.25 volts. If the filter voltage is incorrect, refer to the filter adjustment procedure.

TABLE 4-1. TEST EQUIPMENT REQUIRED

Type of Equipment	Suggested Manufacturer Name and Model No.	Use
VTVM	RCA Model WV-98C	Voltage and resistance measurements
Oscilloscope	Tektronix 531A with Type B plug-in unit	General waveform analysis
RF Voltmeter	Boonton Radio Model 91-C with VHF probe (Model 91-3A) and 52-ohm adapter (Model 91-8A)	Measure output voltage
Electronic Counter	Hewlett-Packard Model 5244L	Frequency measurements
DC Power Supply	Singer Model MF-50 or MF-2 Main Frame, Singer Model MF-8 Rack Mounting Assembly, or any power supply providing 11.0±0.1 volts dc at 100 ma (min.) with less than 0.020 volt peak to peak ripple.	Provides 11 volts dc to the Tuning Head
Tuning Tool	General Cement Model 9089	Alignment
Spectrum Analyzer	Singer Model SPA-12	Measure spurious oscillations
Attenuator, 20dB, 50 ohm	Any commercially acceptable model	Used with SPA-12 Analyzer

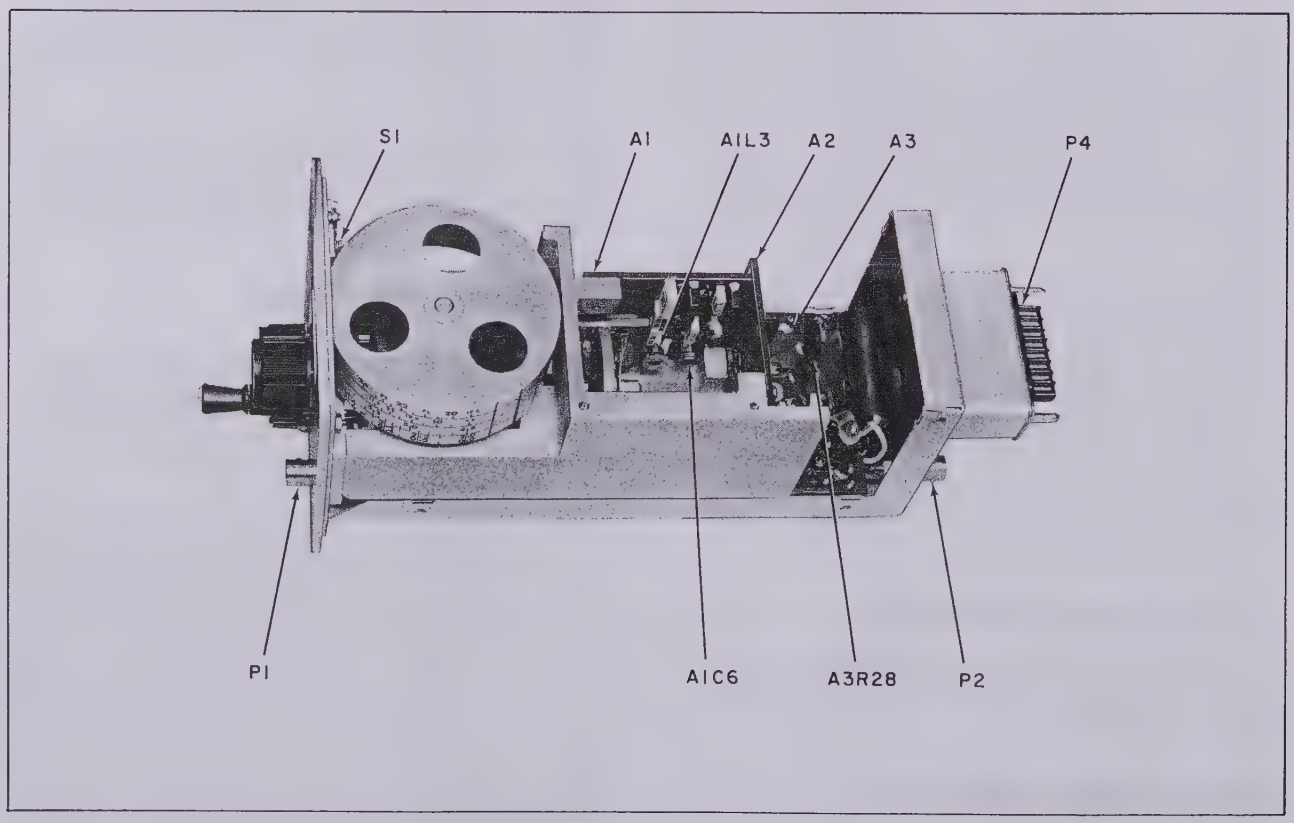


Figure 4-1. Tuning Head with Top Cover and Oscillator Cover Removed, Side View

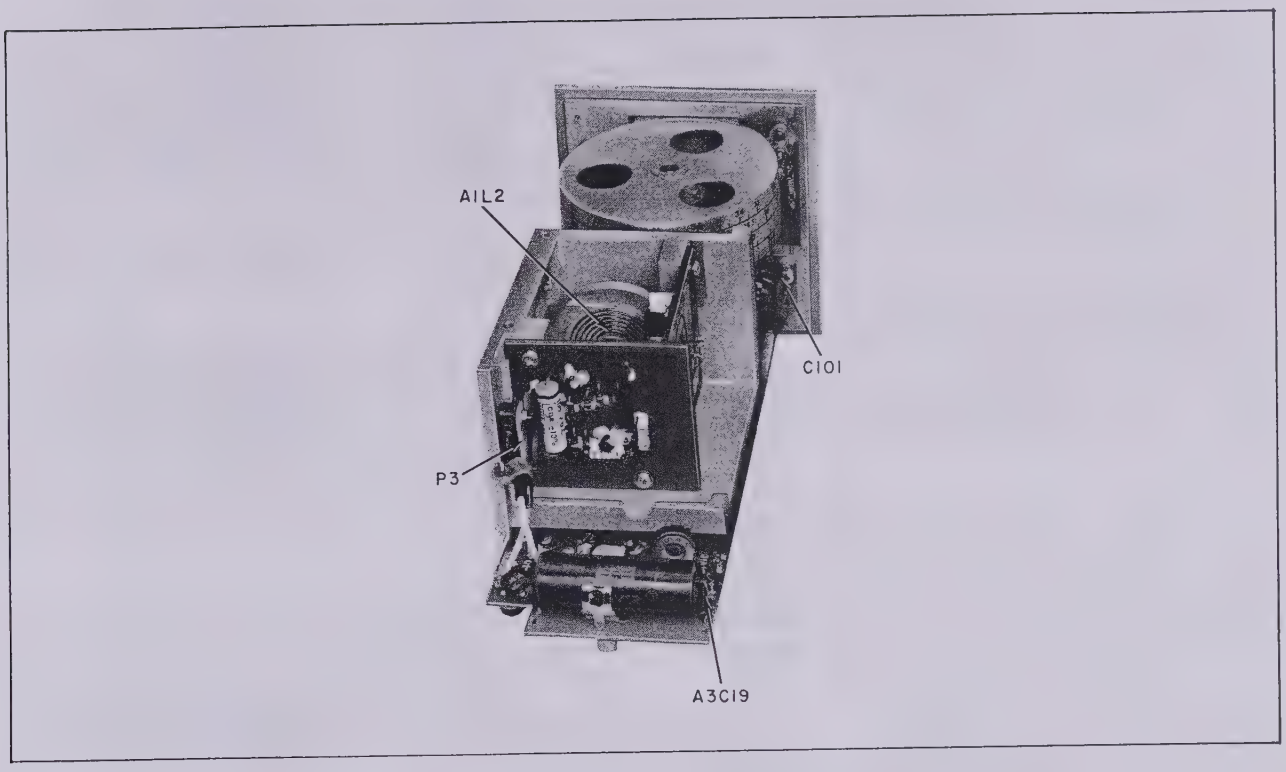


Figure 4-2. Tuning Head Completely Removed from Case, Rear View

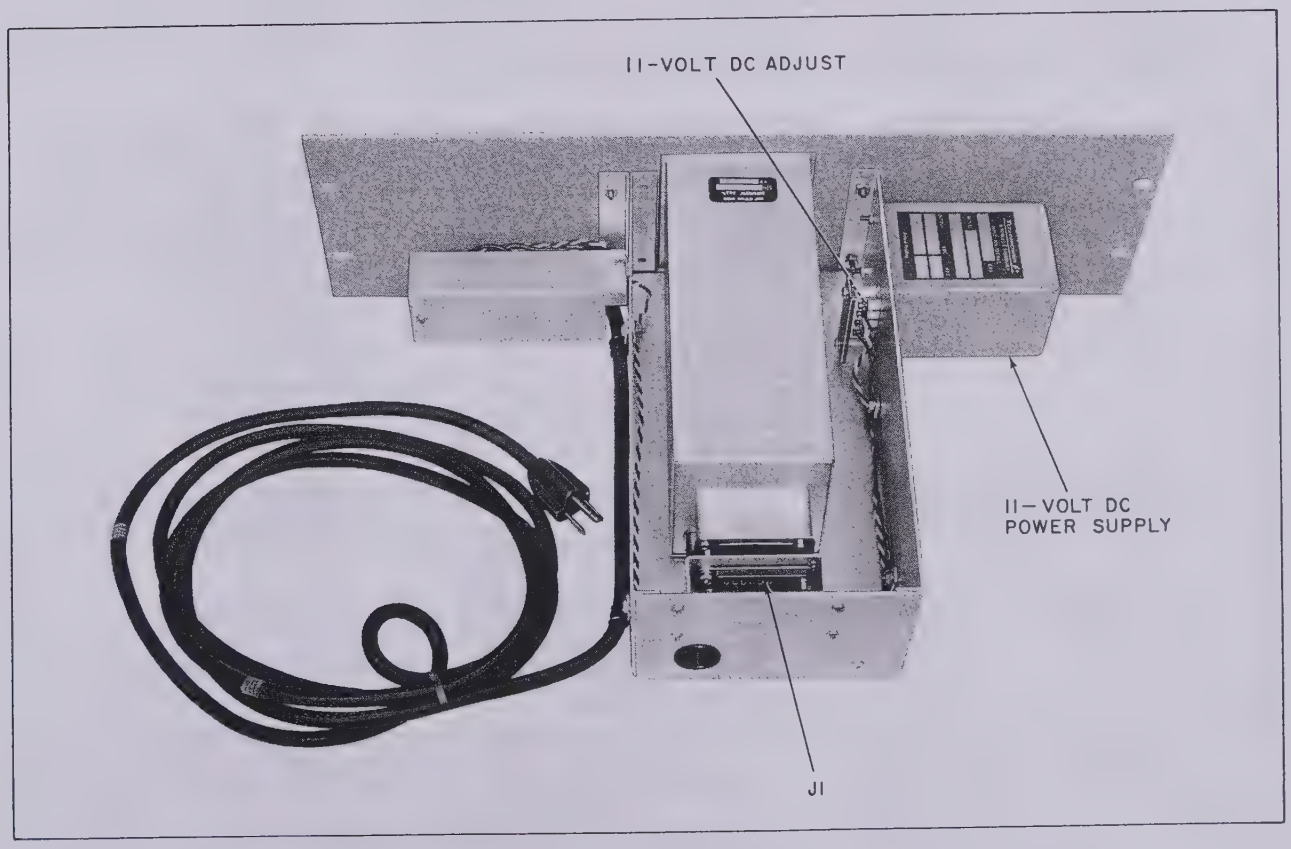


Figure 4-3. Rack Mounting Assembly (With Tuning Head Installed), Rear View

TABLE 4-2. MINIMUM PERFORMANCE STANDARDS CHECKS

Step	Purpose	Procedure	Acceptable Indication
1	To check output level of tuning head.	Connect the RF voltmeter to the OUTPUT 50Ω connector. Place the RANGE switch in the following positions and measure the output voltage: a.) 2.0 to 4.5 MHz b.) 4.5 to 9.5 MHz c.) 9.5 to 19.5 MHz d.) 19.5 to 40 MHz	Output voltage between 0.250 and 0.550 volts rms.
2	To check frequency dial accuracy.	Connect electronic counter to the OUTPUT 50Ω connector. Place RANGE switch in the following positions: a.) 2.0 to 4.5 MHz b.) 4.5 to 9.5 MHz c.) 9.5 to 19.5 MHz d.) 19.5 to 40 MHz Set the tuning control to the highest frequency in the selected range. Measure the corresponding output frequency.	Output frequency equal to the indicated frequency plus 500 KHz, within a tolerance of ±1%.
3	To check frequency drift of tuning head.	Connect electronic counter to OUTPUT 50Ω connector. Allow unit to warm up for at least 20 minutes. Set the output frequency to 30 MHz and measure the frequency change using 10-second sampling intervals.	Frequency change less than 18 Hz per 10-second interval.
4	To check tuning head for spurious oscillations.	a) Set tuning head to 40 MHz b) Connect OUTPUT 50 Ω connector to spectrum analyzer through the 20 dB attenuator. c) Set analyzer range to 40-300 MHz. d) Set the analyzer SWEEP WIDTH control to 5 MHz. e) Adjust the amplitude of the input to be constant during the measurements. f) Slowly rotate the analyzer tuning control to examine the entire 40 to 300 MHz range.	All parasitic oscillations should be -60 dB below the Tuning Head signal level. (Disregard indications for harmonically related frequencies or images).
5	To check noise in Tuning Head.	Since this procedure is quite involved (requiring the use of special test jigs) it has been omitted from the manual. If performance of this procedure is required, contact the Applications Engineering Department of The Singer Company for the test procedure.	0.5 Hz (maximum) at 30 MHz.

4-17. SYSTEMATIC TROUBLE LOCALIZATION.

4-18. Systematic trouble localization is a basic approach to isolating trouble to a particular circuit or area merely from a series of measurements at key points in the Tuning Head. Table 4-3 describes a method of localizing several different possible troubles by using the RANGE switch setting as a means to signal trace to the various circuits of the Tuning Head. In order to perform trouble localization, the Tuning Head must be powered using the 16-connector service cable.

4-19. Once the trouble has been localized to a particular area, the next step is to check the various components. This is best accomplished by checking the voltage measured at the transistor terminals against the typical values presented in table 4-4. A difference between the measured voltage value and the typical value will indicate which circuit or component is malfunctioning.

4-20. ALIGNMENT AND CALIBRATION.

4-21. Alignment and calibration of Tuning Head may be necessary after the unit has been repaired or after extreme component aging. The need for realignment will show up during the minimum performance standards check.

4-22. Remove the unit from the main frame or Rack Mounting Assembly and remove the top cover. Energize the unit with the supplied 16-connector service cable. Allow the unit to warm up for 20 minutes.

4-23. FILTER ADJUSTMENT.

a. Connect VTVM between terminals A3-7 (negative) and A3-10 (positive).

b. Place the RANGE switch in any position except OFF.

c. Tune oscillator through entire range by rotating the tuning control and note the setting causing the smallest voltage reading.

d. Return to that point and adjust potentiometer A3R28, to provide a voltage reading of 0.25 volts dc.

e. Tune the entire frequency range to ensure that the highest reading does not exceed 1.25 volts dc.

4-24. FREQUENCY CALIBRATION.

a. Connect the electronic counter to the OUTPUT 50Ω connector.

b. Set the RANGE switch to 19.5 - 40.0 MHz.

Note

All final frequency readings must be made with the oscillator cover held tightly in place. When the cover is removed, the frequency will vary by a few hundred kHz. It will also vary when the tuning tool is inserted into the trimmer as a result of the capacity of the

TABLE 4-3. SYSTEMATIC TROUBLE LOCALIZATION

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
1	Connect the Tektronix Oscilloscope to the OUTPUT 50Ω connector. Set the RANGE switch to 19.5-40.0 MHz and the frequency to 30 MHz.	Approximate sine wave at 30.5 MHz with amplitude from 0.250 to 0.550 volts RMS.	Proceed to step 2.	Check the oscillator and amplifier.
2	Set the RANGE switch to 9.5 - 19.5 MHz and the frequency to 15 MHz.	Approximate square wave at 15.5 MHz same amplitudes as step 1.	Proceed to step 3.	Check flip-flop A3Q1-Q2.
3	Set the RANGE switch to 4.5 - 9.5 MHz and the frequency to 6 MHz.	Approximate square wave at 6.5 MHz same amplitudes as step 1.	Proceed to step 4.	Check flip-flop A3Q3-Q4.
4	Set the RANGE switch to 2.0-4.5 MHz and the frequency to 3 MHz.	Approximate square wave at 3.5 MHz with same amplitudes as step 1.		Check flip-flop A3Q5-Q6.

operator's hand. Therefore, adjustments made (with the cover removed) should also compensate for the frequency variations which will occur when the cover is replaced.

c. With the RANGE switch set to 19.5 - 40.0 MHz, determine the tuning band total range by measuring the frequency at the lower and upper end limits of the MHz tuning dial, and subtracting the lower frequency indication from the higher frequency indication.

d. Set the MHz tuning dial to its upper end limit and note the indication on the electronic counter. If the total range recorded in step c was less than 21 MHz (±5 kHz), adjust the core of C3 in a clockwise direction until the frequency indicated on the counter increases by an amount equal to the difference between the total range measured in step c and the required 21 MHz range. If the total range recorded in step c was greater than 21 MHz (±5 kHz), adjust the core of L3 in a counterclockwise direction until the frequency indicated on the electronic counter decreases by an amount equal to the difference between the total range measured in step c and the required range.

e. With the cover on, adjust trimmer C6 until the electronic counter indicates 40.75 MHz ±5 kHz.

f. Repeat steps c through e until the electronic counter indicates 19.75 MHz (±5 kHz) and 40.75 MHz (±5 kHz) at the lower and upper limits of the MHz tuning dial, respectively.

TABLE 4-4. VOLTAGE MEASUREMENTS

Reference Designation	Transistor Type	Terminal Voltage (-vdc)			Notes
		Base	Emitter	Collector	
A1Q1	2N3646	6.2	5.4	2.0	1. All voltages taken with respect to chassis ground with an RCA Model WV-98C VTVM. 2. RANGE switch set to 2.0 - 4.5 MHz.
A2Q1	2N3646	6.0	6.6	3.5	
A2Q2	2N3646	6.5	7.1	0	
A3Q1	2N3646	3.3	3.8	1.65	
A3Q2	2N3646	3.3	3.8	1.85	
A3Q3	2N3646	7.0	7.3	5.5	
A3Q4	2N3646	7.0	7.3	5.5	
A3Q5	2N3646	10.4	11.0	9.5	
A3Q6	2N3646	10.4	11.0	8.9	
A3Q7	2N3567	10.3	11.0	9.0	

SECTION V

SCHEMATIC DIAGRAMS

NOTES

UNLESS OTHERWISE INDICATED:
1. ALL RESISTANCE VALUES ARE IN OHMS, 1/4W, ±5%.
2. ALL CAPACITANCE VALUES ARE IN PICOFARADS.
3. ALL DIODES ARE IN995.
4. * G=CORNING GLASS CAPACITOR.
   M=METAL FILM RESISTOR, 1/4W, ±5%.
   V=VITRAMON PORCELAIN CAPACITOR.
5. ▭ INDICATES PANEL MARKING.

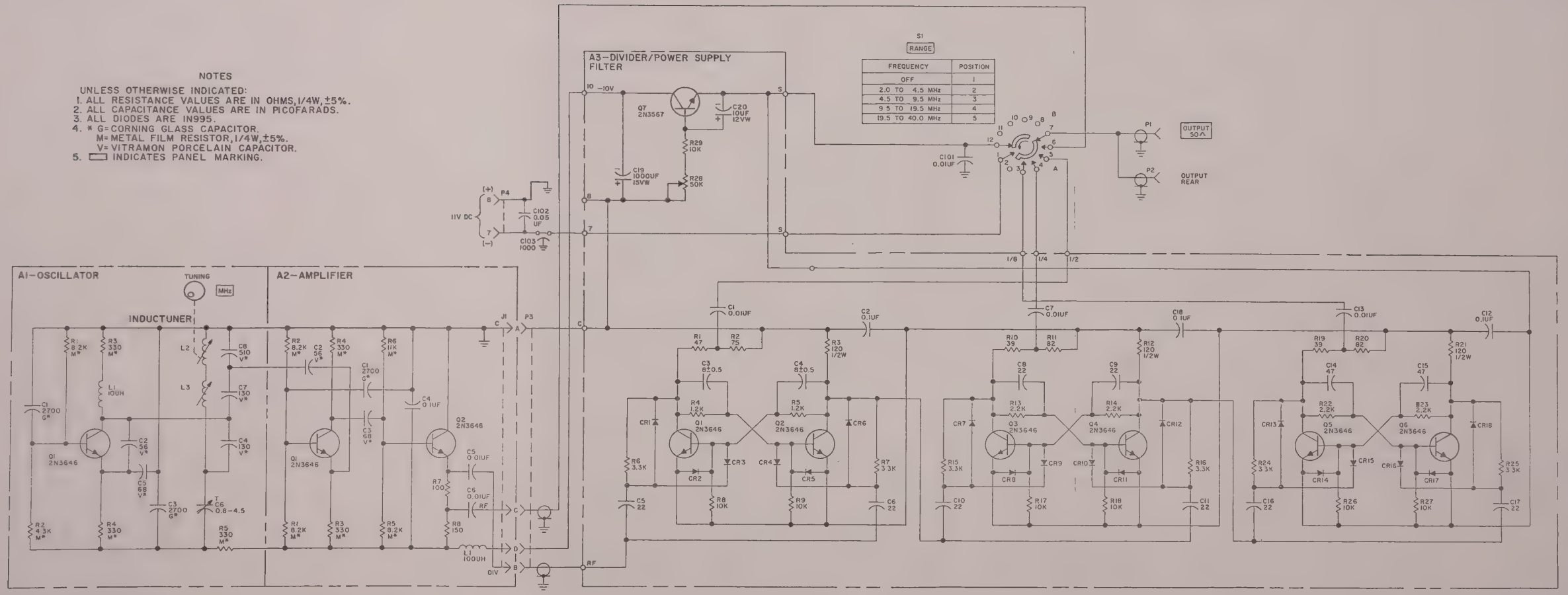


Figure 5-1. Tuning Head, Schematic Diagram

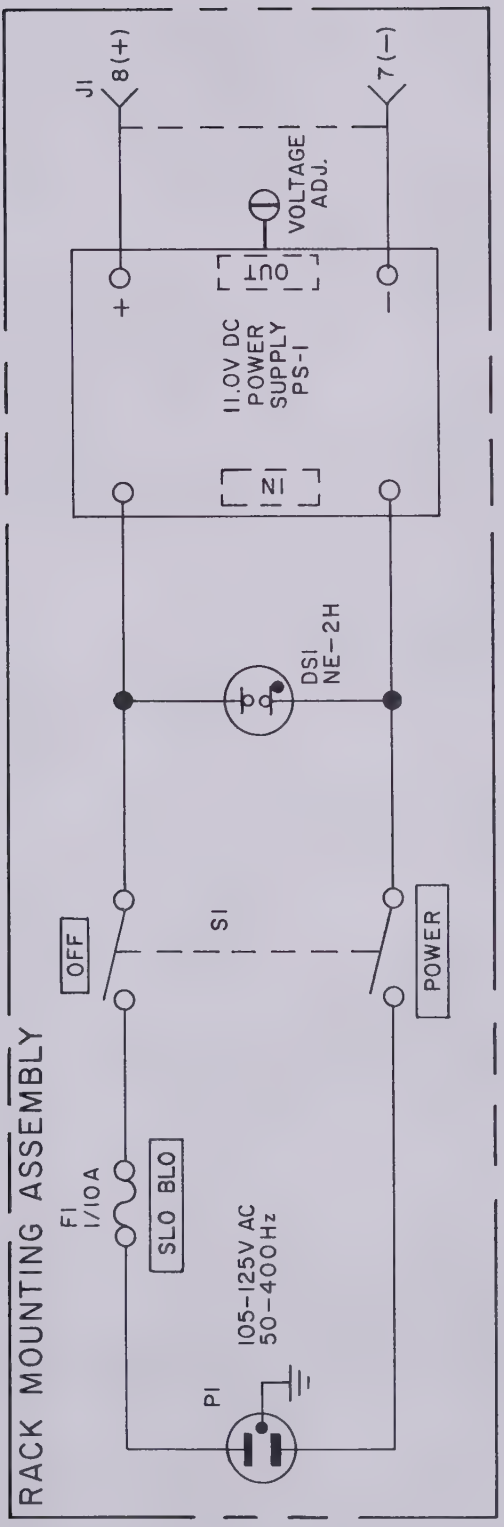


Figure 5-2. Rack Mounting Assembly, Schematic Diagram

SECTION VI

PARTS LIST

6-1. INTRODUCTION

6-2. This parts list section includes all pertinent data necessary to locate, identify, and procure additional parts for the equipment. Parts are listed alpha-numerically by reference symbol and include all replaceable items such as electronic, electro-mechanical, and mechanical parts of the equipment. In some cases, values, ratings and manufacturer sources shown are nominal and variations may be found. Satisfactory replacement may be made with either the listed component or an exact replacement of the part(s) removed from the equipment.

6-3. ORDERING INFORMATION.

6-4. The following instructions will aid in ordering parts from the Parts List, table 6-2.

a. Address all inquiries or orders to:

CUSTOMER SERVICE
Department 500-1
The Singer Company
Metrics Division
915 Pembroke Street
Bridgeport, Connecticut 06608

b. Include the following information:

1) Model and Serial Number of instrument.

2) Singer Part Number.

3) Reference Symbol Number.

4) Description (as shown on list)

6-5. HOW TO USE THE PARTS LIST.

6-6. Paragraphs 6-7 through 6-11 describe the use and meaning of the five columns included in the parts list, table 6-2 (see figure 6-1).

6-7. REF SYMBOL COLUMN. The Ref Symbol Column (1, figure 6-1) contains a alpha-numerical listing of parts as they appear on equipment chassis, illustration, or schematic. The reference designation identifies the parts as to their component function in the instrument.

6-8. DESCRIPTION COLUMN. The Description Column (2, figure 6-1) contains the identification of component parts including all pertinent specifications and Singer part number. When the description column is used for a part which is identical to a part which has already been described: SAME AS (3) is used along with the reference symbol of the previously used part. In these instances, columns 3, 4, 5 are left blank. When the description column is used for a reference symbol for which no part exists; NOT USED (4) is placed in the column. In these instances, columns 3, 4, 5, are left blank.

6-9. MANUFACTURER'S PART NUMBER COLUMN. The Manufacturer's Part Number Column (5, figure 6-1) contains the part number as designated by the manufacturer of the part.

6-10. MFR'S CODE COLUMN. The Mfr's Code column (6, figure 6-1) references the manufacturer by an assigned code number as listed in Federal Supply Code Handbook H4-2. For manufacturers not listed in H4-2, a letter code will be assigned. Table 6-1 includes the manufacturer and his code designation.

6-11. MAINT QTY COLUMN. The Maint Qty column (7, figure 6-1) contains the number of additional components recommended to keep the equipment at an optimum performance level. The recommended number of components in the Maint Qty column is based on 2000 hours of equipment operation.

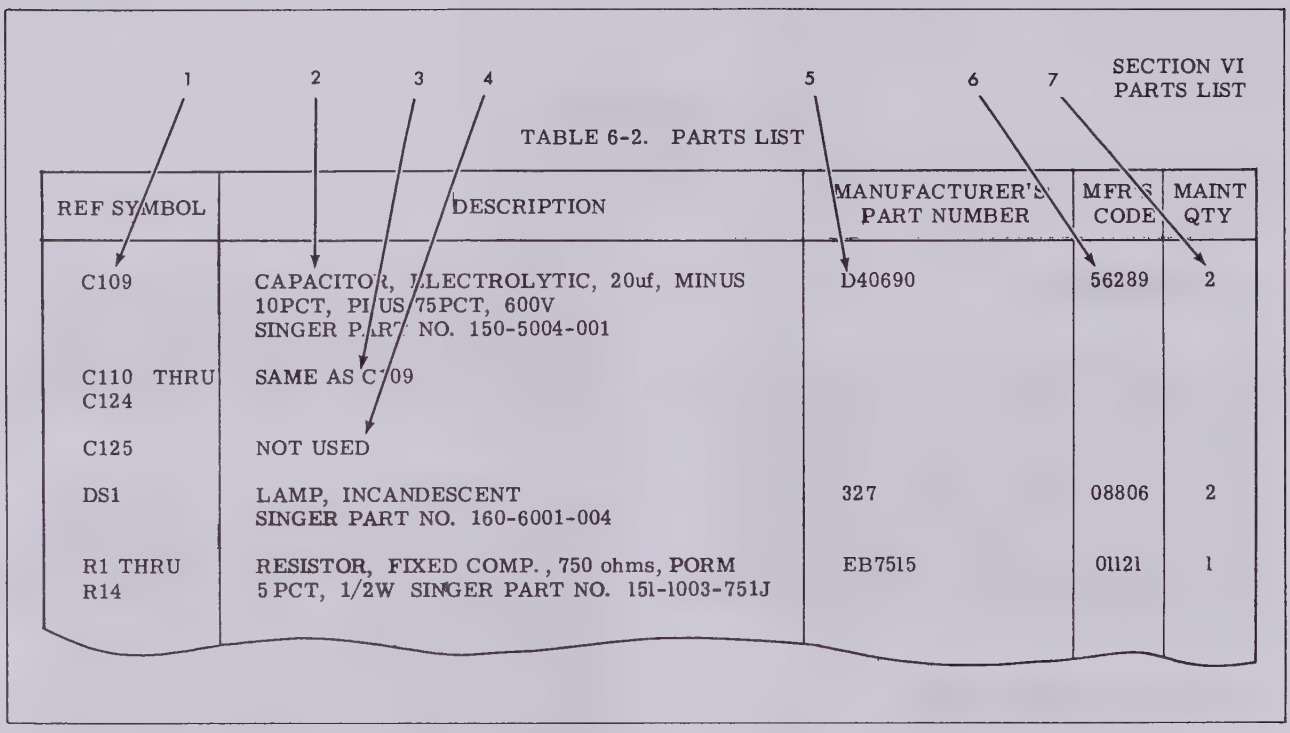


Figure 6-1. Parts List Sample

TABLE 6-1. MANUFACTURER'S CODE

Number	Name	Number	Name
01121	Allen-Bradley Co., Milwaukee, Wis.	71400	Bussmann Mfg. Division of McGraw Edison Co. St. Louis, Mo.
02660	Amphenol-Borg Electronics Corp., Maywood, Ill.	71450	CTC Corp., Elkhart, Ind.
04009	Arrow-Hart and Hegeman Electric Co., Hartford, Conn.	71590	Centralab Division of Globe-Union Inc. Milwaukee, Wis.
09023	Cornell-Dubilier Electric Corp., Electrolytics and Paper Tubular Division Sanford, N.C.	72136	Electro-Motive Mfg. Co., Inc. Willimantic, Conn.
13850	Technipower Inc., South Norwalk, Conn.	72982	Erie Technological Products, Inc. Erie, Pa.
16299	Corning Glass Works Electronic Components Division Raleigh, N.C.	81312	Winchester Electronics Division Litton Industries Inc., Oakville, Conn.
16665	The Singer Co., Metrics Division Bridgeport, Conn.	81349	Military Specifications
18736	Voltronics Corp., Hanover, N.J.	82142	Jeffers Electronics Division of Speer Carbon Co., DuBois, Pa.
56289	Sprague Electric Co., North Adams, Mass.	91802	Industrial Devices, Inc. Edgewater, N.J.
		95263	Leecraft Mfg. Co., Inc., L.I.C., N.Y.
		95275	Vitramon Inc., Bridgeport, Conn.

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
C101	CAPACITOR,FIXED,CERAMIC DISC, 0.01 UF,250V SINGER PART NO. 556060-146	DA140-172B	71590	1
C102	CAPACITOR,CERAMIC DISC, 0.05 UF,100 V SINGER PART NO. 556120-180	845-000X5V0503Z	72982	1
C103	CAPACITOR,FIXED,FEED-THRU, 1000 PF,PORM 20 PCT,500V SINGER PART NO. 556060-071	X5S-1000	72982	1
DS1	LAMP,PILOT,NEON,WHITE SINGER PART NO. 160-6006-004 USED IN MF-8 ONLY	2110A4	91802	1
F1	FUSE,DELAY,1/10 AMP SINGER PART NO. 556146-887 USED ON MF-8 ONLY	AGC-1/10	71400	3
J1	CONNECTOR,JACK SINGER PART NO. 556166-045	26-159-16	02660	1
J1	CONNECTOR,JACK SINGER PART NO. 556166-046 USED IN MF-8 ONLY	26-190-16	02660	1
PS1	POWER SUPPLY SINGER PART NO. 132-0207-001 USED IN MF-8 ONLY	M-10.8-0.200	13850	1
P1	CORD,POWER USED IN MF-8 ONLY	556161-067	16665	1
P1 AND P2	CONNECTOR,PLUG SINGER PART NO. 168-4006-001	UG1094/U	81349	1
P3	CONNECTOR,PLUG SINGER PART NO. 556146-389	JF4S	81312	1
S1	SWITCH,ROTARY	133-0055-001	16665	1
S1	SWITCH,TOGGLE SINGER PART NO. 556019-043 USED IN MF-8 ONLY	81024-GB	04009	1
A1C1	CAPACITOR,FIXED,GLASS, 2700 PF, PORM 5 PCT SINGER PART NO. 556146-379	TY08-272J	16299	1
A1C2	CAPACITOR,FIXED,PORCELAIN, 56 PF,PORM 5 PCT, 500V SINGER PART NO. 556146-562	VY10CA560JE	95275	1
A1C3	SAME AS A1C1			
A1C4	CAPACITOR,FIXED,PORCELAIN, 130 PF,PORM 2 PCT 100V SINGER PART NO. 556146-563	VY10CA131GE	95275	1
A1C5	CAPACITOR,FIXED,PORCELAIN, 68 PF,PORM 5 PCT, 300V SINGER PART NO. 556146-561	VY10CA680JE	95275	1
A1C6	CAPACITOR,VARIABLE, 0.8 TO 4.5 PF SINGER PART NO. 556146-388	V1251	18736	1
A1C7	SAME AS A1C4			
A1C8	CAPACITOR,FIXED,PORCELAIN, 510 PF,PORM 5 PCT 100V SINGER PART NO. 556146-564	VY15CA511JE	95275	1
A1L1	COIL,RF, 10 UH SINGER PART NO. 556146-377	4446-4	82142	1
A1L2	INDUCTUNER	103-1259-001	16665	1
A1L3	COIL	132-0150-001	16665	1
A1Q1	TRANSISTOR	149-0146-001	16665	1

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A1R1	RESISTOR,FIXED,PREC., 8.2K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 556146-386	TYPE C07	16299	1
A1R2	RESISTOR,FIXED,PREC., 4.3K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 556146-385	TYPE C07	16299	1
A1R3 THRU A1R5	RESISTOR,FIXED,PREC., 330 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 556146-384	TYPE C07	16299	1
A2C1	SAME AS A1C1			
A2C2	SAME AS A1C2			
A2C3	SAME AS A1C5			
A2C4	CAPACITOR,FIXED,MYLAR, 0.1 UF,PORM 10 PCT, 100V SINGER PART NO. 556120-130	WMF1P1	09023	1
A2C5 AND A2C6	SAME AS C101			
A2J1	SAME AS P1			
A2L1	COIL,RF, 100 UH SINGER PART NO. 556012-191	1326-7	82142	1
A2Q1	SAME AS A1Q1			
A2Q2	TRANSISTOR SINGER PART NO. 556146-256	2N3646	81349	1
A2R1 AND A2R2	SAME AS A1R1			
A2R3 AND A2R4	SAME AS A1R3			
A2R5	SAME AS A1R1			
A2R6	RESISTOR,FIXED,PREC., 11K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 556146-387	TYPE C07	16299	1
A2R7	RESISTOR,FIXED,COMP., 100 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-101J	CB1015	01121	1
A2R8	RESISTOR,FIXED,COMP., 150 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-151J	CB1515	01121	1
A3CR1 THRU A3CR18	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556146-146	IN995	81349	1
A3C1	SAME AS C101			
A3C2	SAME AS A2C4			
A3C3 AND A3C4	CAPACITOR,FIXED,DIPPED MICA, 8 PF, PORM 0.5 PF,500V SINGER PART NO. 150-2002-8ROCDO	DM15C8ROD0500WV4CR	72136	1
A3C5 AND A3C6	CAPACITOR,FIXED,DIPPED MICA, 22 PF, PORM 5 PCT,500V SINGER PART NO. 150-2002-220CJO	DM15C220J0500WV4CR	72136	1
A3C7	SAME AS C101			
A3C8 THRU A3C11	SAME AS A3C5			

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A3C12	SAME AS A2C4			
A3C13	SAME AS C101			
A3C14 AND A3C15	CAPACITOR,FIXED,DIPPED MICA, 47 PF, PORM 5 PCT,500V SINGER PART NO. 150-2002-470EJO	DM15E470J0500WV4CR	72136	1
A3C16 AND A3C17	SAME AS A3C5			
A3C18	SAME AS A2C4			
A3C19	CAPACITOR,ELECTROLYTIC, 1000 UF,15V SINGER PART NO. 556074-146	BR-1000-15	09023	1
A3C20	CAPACITOR,ELECTROLYTIC, 10 UF,12V SINGER PART NO. 556074-001	TE-1128	56289	1
A3Q1 THRU A3Q6	SAME AS A2Q2			
A3Q7	TRANSISTOR SINGER PART NO. 556146-376	2N3567	81349	1
A3R1	RESISTOR,FIXED,COMP.,47 OHMS,PORM 5 PCT,1/4W SINGER PART NO. 151-1002-470J	CB4705	01121	1
A3R2	RESISTOR,FIXED,COMP.,75 OHMS,PORM 5 PCT,1/4W SINGER PART NO. 151-1002-750J	CB7505	01121	1
A3R3	RESISTOR,FIXED,COMP.,120 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-121J	EB1215	01121	1
A3R4 AND A3R5	RESISTOR,FIXED,COMP.,1.2K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-122J	CB1225	01121	1
A3R6 AND A3R7	RESISTOR,FIXED,COMP.,3.3K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-332J	CB3325	01121	1
A3R8 AND A3R9	RESISTOR,FIXED,COMP.,10K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-103J	CB1035	01121	1
A3R10	RESISTOR,FIXED,COMP.,39 OHMS,PORM 5 PCT,1/4W SINGER PART NO. 151-1002-390J	CB3905	01121	1
A3R11	RESISTOR,FIXED,COMP.,82 OHMS,PORM 5 PCT,1/4W SINGER PART NO. 151-1002-820J	CB8205	01121	1
A3R12	SAME AS A3R3			
A3R13 AND A3R14	RESISTOR,FIXED,COMP.,2□2K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-222J	CB2225	01121	1
A3R15 AND A3R16	SAME AS A3R6			
A3R17 AND A3R18	SAME AS A3R8			
A3R19	SAME AS A3R10			
A3R20	SAME AS A3R11			
A3R21	SAME AS A3R3			
A3R22 AND A3R23	SAME AS A3R13			

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A3R24 AND A3R25	SAME AS A3R6			
A3R26 AND A3R27	SAME AS A3R8			
A3R29	SAME AS A3R8			
A3R28	RESISTOR,VARIABLE, 50K OHMS,PORM 30 PCT,1/4W SINGER PART NO. 556056-129	X201R503B	71450	1

INSTRUCTION MANUAL

RANGE EXTENDING CONVERTER

MODEL REC-2

Serial No._____

Instruction Manual No. 110-5032

SINGER
INSTRUMENTATION

THE SINGER COMPANY • INSTRUMENTATION DIVISION

Creative Products for Test, Measurement, Analysis, Calibration

ADDENDUM

for

MODEL REC-2
(Effective on Serial No. U15960 and above)

Make the following change to the List of Replaceable Parts.

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A1A1L1	CHOKE, 9.2 UH Singer P/N 556012-157	10203-25	82142	1

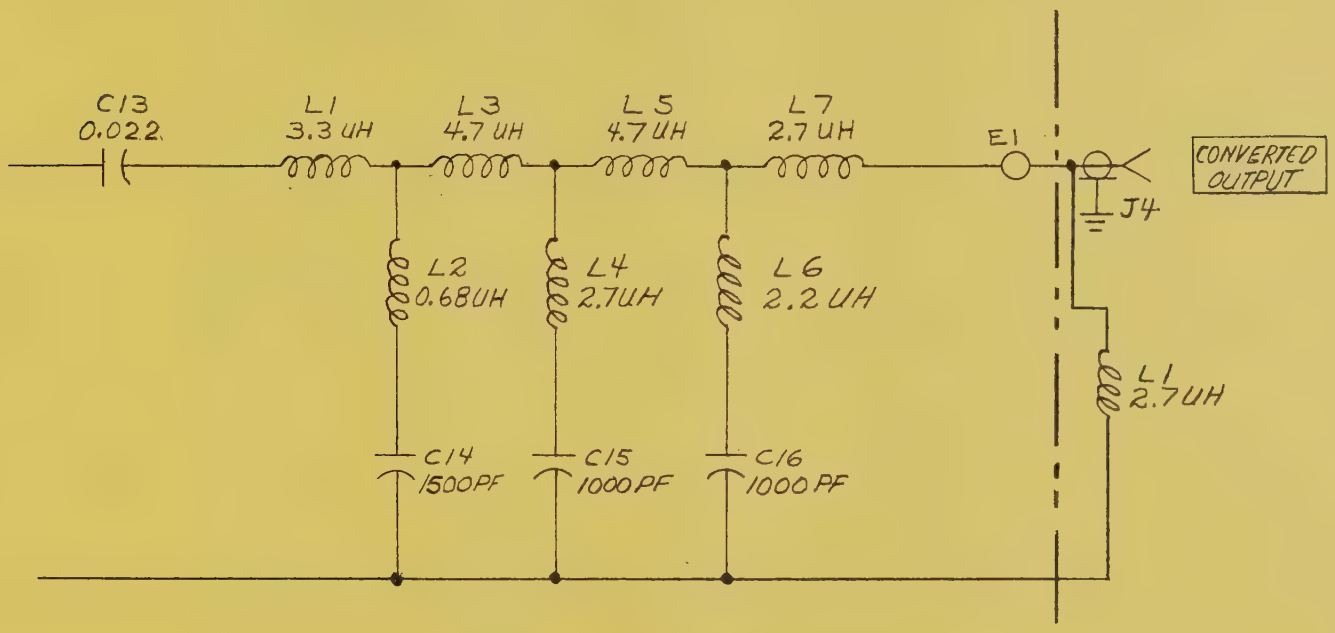
Addendum No. 497

ADDENDUM

for

MODEL REC-2

In figure 5-1, change the existing schematic as illustrated below:



Addendum No. 507
(00 to 01)

ADDENDUM

for

MODEL REC-2 & REC-2/GD

Make the following changes to the List of Replaceable Parts.

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
J2 AND J3	CONNECTOR, JACK SINGER PART NO. 139-0019-001	13762	91737	1
A1A3R2 AND R3	RESISTOR, FIXED, COMP., 1K OHM, PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-102J	CB1025	01121	1
A3L2	CHOKE, 0.68UH SINGER PART NO. 556146-777	4426-4K	78429	1

Addendum No. 534

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Figure 1-1. Model REC-2 Range Extending Converter

SECTION I
INTRODUCTION

1-1. SCOPE OF MANUAL.

1-2. This instruction manual provides operating and maintenance instructions for the PANORAMIC* Range Extending Converter, Model REC-2 (hereafter referred to as the Converter), manufactured by The Singer Company, Metrics Division. Included in the manual are a general description of the Converter, installation and operating instructions, theory of operation, maintenance information and data, a schematic diagram and a repair parts list. The Converter is illustrated in figure 1-1.

1-3. The information contained in this manual refers to the standard version of the Converter and is current only to the date of publication. Differences in equipment components, specifications, and performance resulting from The Singer Company's continuous production improvement program or individual customer design and application requirements are described in addendum sheets.

1-4. PURPOSE AND USE OF EQUIPMENT.

1-5. The Converter is a plug-in unit primarily designed to convert the frequency spectrum between 10 Hz and 2 MHz to 2. 5 MHz when used with the Model RF-8 Tuning Head and Model CA-5 Panalyzor in the PANORAMIC Model SSB-50 Single Sideband Analyzer System. The Converter, RF-8, and CA-5 configuration provides spectrum analysis in the 10-Hz to 2-MHz frequency range. Typical applications include:

a. Audio frequency spectrum analysis.

b. Ultrasonic spectrum analysis.

c. Analysis of signals in the base band of telephone and telegraph carrier systems.

d. Single sideband receiver distortion and sensitivity measurements (with the addition of a Model TTG-5 Two-tone R-f Generator to the configuration).

1-6. Inquiries are invited regarding special applications of the Converter to particular requirements. Such inquiries should be directed to the attention of the Applications Engineering Department.

1-7. GENERAL DESCRIPTION.

1-8. The Converter is a completely solid-state plug-in unit which operates in conjunction with a variable frequency oscillator (VFO) such as the PANORAMIC Model RF-8 Tuning Head to convert the frequency spectrum between 10 Hz and 2 MHz to 2. 5 MHz. The 2. 5-MHz converted output is then heterodyned in the input mixer of the CA-5 Panalyzor with a 3-MHz oscillator output from the Converter to produce the required 500-kHz center frequency input signal to the CA-5 Panalyzor. The Converter occupies a quarter-rack width in such units as the Model MF-50 Main Frame of the Model SSB-50 Single Sideband Analyzer System. Components are mounted on the rear of the front panel and on five printed circuit boards. Operating power for the Converter is provided by the main frame in which it is installed, thereby eliminating the need for an integral power supply.

1-9. SPECIFICATIONS.

1-10. Table 1-1 lists the electrical and physical characteristics of the Converter.

1-11. TRANSISTOR, DIODE, AND CRYSTAL COMPLEMENT.

1-12. The transistor, diode, and crystal complement of the Converter is given in table 1-2.

TABLE 1-1. SPECIFICATIONS

Input frequency range:	10 Hz to 2 MHz, ±1 dB (Low frequency response limited by resolution capabilities of the associated spectrum analyzer).
Converted output frequency:	2. 5 MHz

(Cont'd)

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TABLE 1-1. SPECIFICATIONS (Cont'd)

Gain:	Approximately unity.
Converted Sensitivity:	3-mv input produces a 3-mv (approximately), 2.5 MHz converted output.
Distortion:	Hum and spurious responses are at least 60 dB below signal output level of 3 mv. Harmonics and intermodulation distortion components are at least 60 dB below 3 mv output, or 70 dB below 1.5 mv output.
Input Attenuator:	Up to 55 dB in 5 dB steps. Accuracy ±10 percent.
Center frequency:	Yellow portion of 2.0 to 4.5 MHz dial on RF-8 Tuning Head is calibrated from 0 to 2 MHz for use with Converter.
VFO requirements:	0.3-volt (nominal), 2.5 to 4.5-MHz input, at 50 ohms.
Signal input impedance:	50 ohms or 600 ohms unbalanced, switch selectable.
Power requirements:	-15 vdc reg. at 40 ma. +15 vdc reg at 40 ma.
Physical characteristics:	
Weight:	3 lbs.
Width:	3 3/4 inches
Height:	4 inches
Depth (behind panel):	10 inches

TABLE 1-2. TRANSISTOR, DIODE, AND CRYSTAL COMPLEMENT

Reference Designation Symbol	Type	Function
	Transistors	
A1A3Q1	2N3638A	3-MHz Osc.
A3Q1, Q2	2N3565	2.5-MHz I-f Amplifier
A3Q3	2N3565	Emitter Follower
	Diodes	
A1A1CR1, CR2 A1A2CR1 thru CR3	FDH666	Diode Switches
A2CR1 thru CR4	1N906	Balanced Mixer Diodes
A1A3Y1	-	Generates 3-MHz output

SECTION II
OPERATION

2-1. GENERAL.

2-2. This section contains installation and operating instructions for the Converter. The Converter has been factory tested and aligned and is shipped in a ready- to-operate condition. However, no attempt should be made to install or operate the unit until the operator is thoroughly familiar with the contents of this section. Figure 2-1 is an outline dimension drawing of the Converter.

2-3. INSTALLATION.

2-4. To install a Converter in the Model MF-50 Main Frame, insert the Converter in the corresponding cavity and firmly seat it in place. If any resistance is noted while inserting the Converter, withdraw it and examine the connectors on the rear of the Converter and the rear wall of the main frame cavity for proper alignment. Tighten the front-panel fastener on the Converter to mechanically secure it to the main frame.

2-5. OPERATION.

2-6. OPERATING CONTROLS AND CONNECTORS. The operating controls and connectors for the Converter are described in table 2-1 and shown in figure 2-2.

2-7. OPERATING PROCEDURE. The following procedure describes how to operate the Converter. The procedure assumes that power is applied to the unit.

a. Set the MODE selector switch to the CONVERTED 10 Hz-2 MHz position when operating with an external VFO to provide a converted 2.5-MHz output.

b. Set the MODE selector switch to the DIRECT position when operating with an external VFO to provide only a VFO output.

c. Set the 50 Ω -600 Ω switch to correspond to the output impedance of the input signal source.

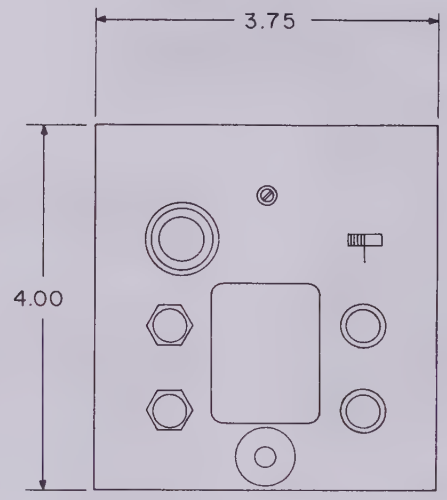
d. Place each ATTEN DB switch to the up position, as required, to reduce the signal level deflection on the CRT of the associated spectrum analyzer.

2-8. PACKAGING INSTRUCTIONS.

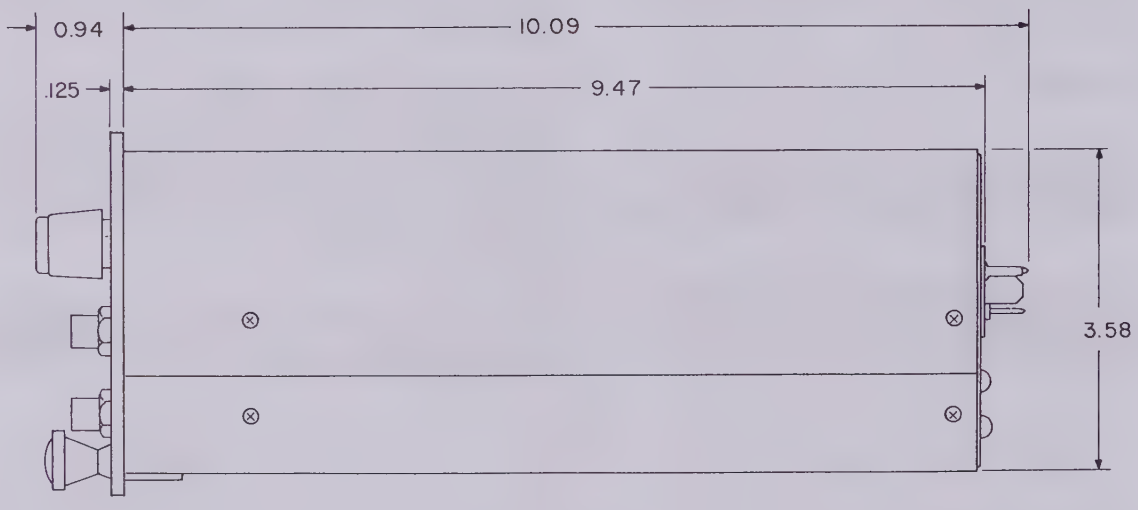
2-9. The following packaging instructions provide information for short-term and long-term storage and shipping of the Converter.

2-10. SHORT-TERM PACKAGING. For short-term packaging, the Converter should be enclosed in a polyethylene bag and placed in a suitable carton for protection. This carton should be stored in a clean and moisture-free area. All accessories and literature should be securely fastened to the equipment in order to prevent loss.

2-11. LONG-TERM PACKAGING AND PACKAGING FOR SHIPMENT. Figure 2-3 illustrates the packaging procedure for the Converter.



Front View



Side View

Figure 2-1. Outline Dimension Drawing, Converter

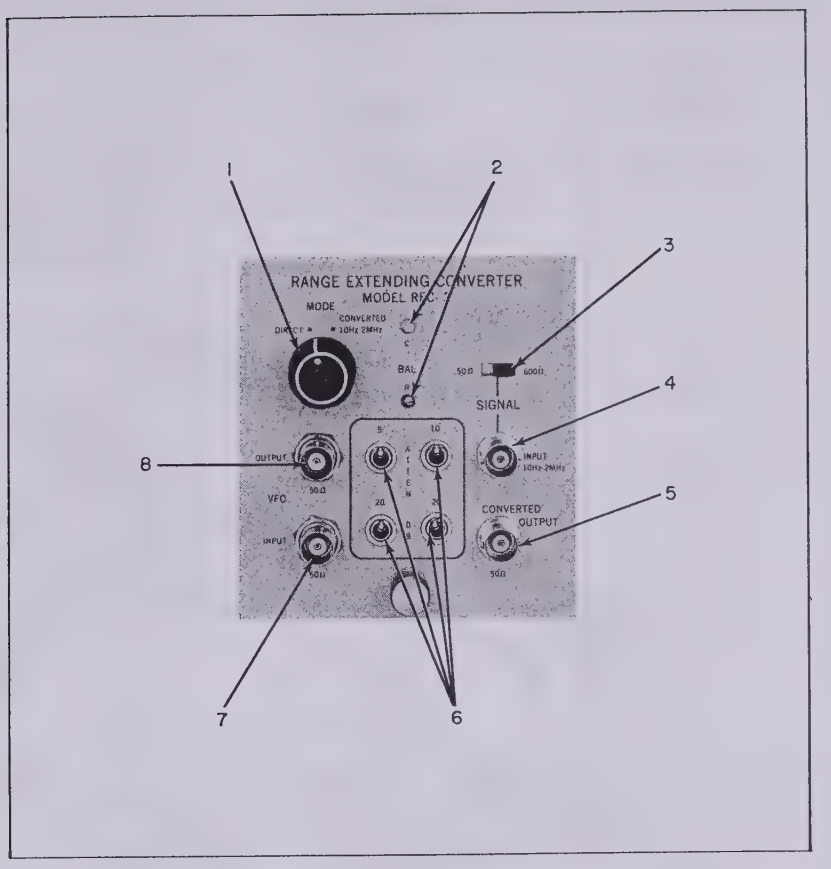


Figure 2-2. Converter, Operating Controls and Connectors

TABLE 2-1. OPERATING CONTROLS AND CONNECTORS

Index No. (Figure 2-2)	Reference Designation	Name	Function
1	S6	MODE selector switch	Selects either 3-MHz oscillator output or direct VFO output. Switches on d-c power to the converter in converted 10 Hz-2 MHz position.
2	C1 R18	C and R BAL screwdriver controls	Suppress external VFO leakage through the balanced mixer at zero input frequency, when the MODE selector switch is set to CONVERTED 10 Hz-2 MHz.
3	S1	50 Ω -600 Ω switch	Sets input impedance of the Converter to 50 or 600 ohms.
4	J1	SIGNAL INPUT 10 Hz-2 MHz jack	Connects the signal intput to the Converter.
5	J4	CONVERTED OUTPUT jack	Provides the 2. 5-MHz converted output to the associated spectrum analyzer.

(Cont'd)

TABLE 2-1. OPERATING CONTROLS AND CONNECTORS (Cont'd)

Index No. (Figure 2-2)	Reference Designation	Name	Function
6	S3 through S5	ATTEN DB switches	Provide input attenuation of 20 dB, 20 dB, 10 dB, and 5 dB. When the switches are in the up position, the indicated attenuation is inserted.
7	J3	VFO INPUT jack	Connects external VFO to the Converter.
8	J2	VFO OUTPUT jack	Connects either external VFO (MODE selector switch in DIRECT position) or 3-MHz oscillator output (MODE selector switch in CONVERTED 10 Hz-2 MHz position) to the associated spectrum analyzer VFO input.

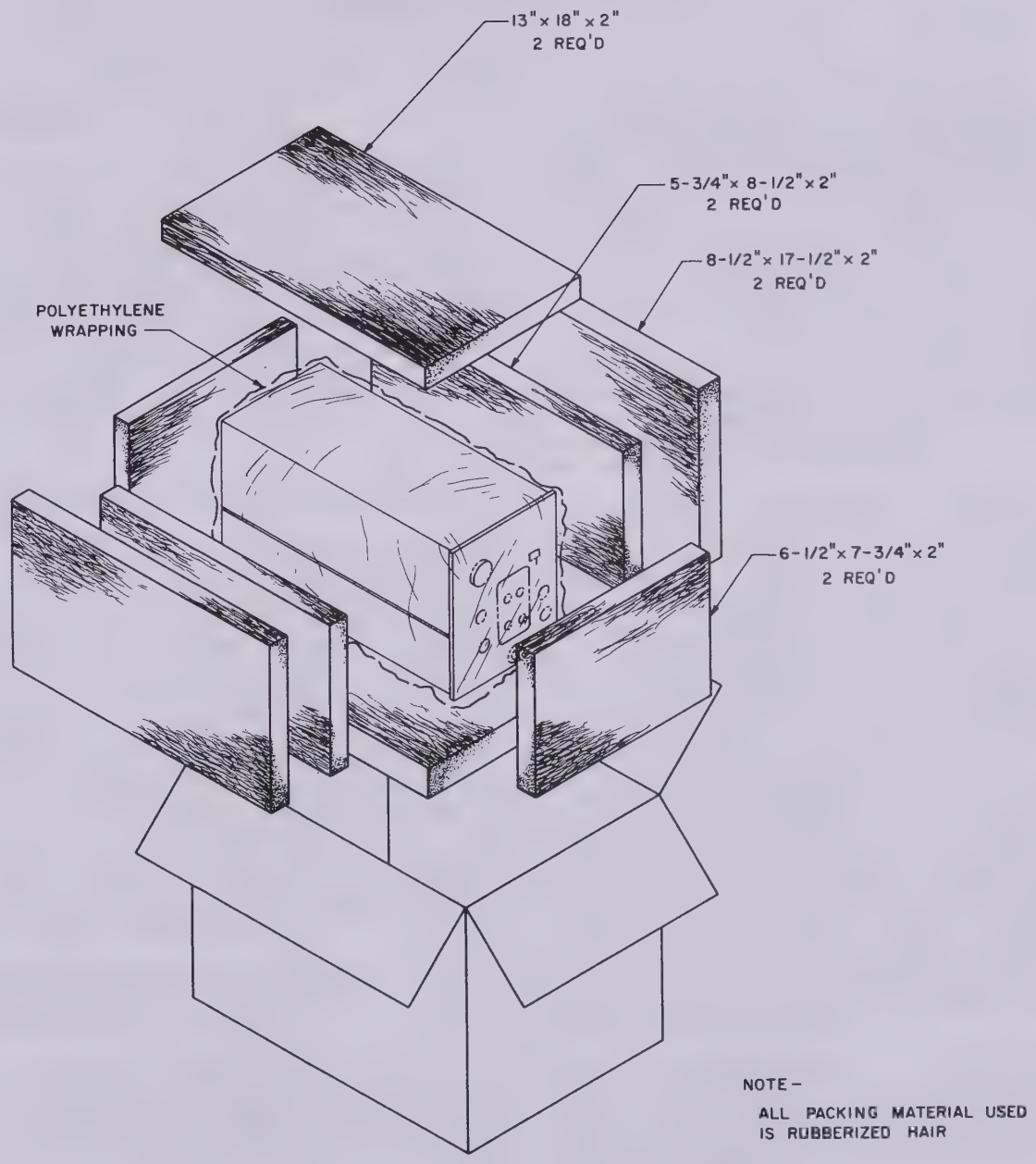


Figure 2-3. Packaging the Converter

SECTION III
THEORY OF OPERATION

3-1. GENERAL.

3-2. This section contains the theory of operation for the Converter. The Converter is a completely solid-state plug-in device that operates in conjunction with a VFO to convert the frequency spectrum between 10 Hz and 2 MHz to 2.5 MHz. The 2.5-MHz converted output is then heterodyned in the companion analyzer, with a 3-MHz oscillator output from the Converter to produce the required 500-kHz center frequency input at its associated spectrum analyzer. Operating power for the Converter is provided by its associated main frame.

3-3. SIMPLIFIED BLOCK DIAGRAM ANALYSIS.

3-4. The Converter (figure 3-1) consists mainly of a balanced bridge mixer which combines the signals appearing at the SIGNAL INPUT 10Hz-2MHz and VFO INPUT jacks when the MODE switch is set to the CONVERTED 10Hz-2MHz position. The difference output of the mixer is amplified by a 2.5-MHz i-f amplifier and routed to the front panel CONVERTED OUTPUT jack. When in the CONVERTED 10Hz-2MHz mode, the 3-MHz oscillator provides an input to the associated spectrum analyzer (via the VFO OUTPUT jack) to effect a final heterodyning of the converted 2.5-MHz output signal to 500kHz. The MODE selector switch provides electronic switching (via diode switches A1A1 and A1A2) of either the 3-MHz oscillator output or direct VFO output. An input attenuator provides up to 55 dB of attenuation to prevent overloading of its succeeding circuits.

3-5. DETAILED THEORY OF OPERATION. (See Figures 3-1 and 5-1)

3-6. The Converter consists of five major sections: the input attenuator; balanced mixer; 2.5-MHz I-f amplifier; 3-MHz oscillator; and diode switches. Each of these is discussed below.

3-7. INPUT ATTENUATOR. The input attenuator consists of four pi-type resistive attenuator pads (R2 through R4, R5 through R7, R8 through R10, and R11 through R13) which are selected by ATTEN DB toggle switches S2 through S5. Up to 55 dB of attenuation (in 5 dB steps) can be inserted in the signal input path by operation of these switches. Toggle switch S1 selects either a 50-ohm or 600-ohm unbalanced input to the attenuator.

3-8. BALANCED MIXER. The balanced mixer employs four type 1N906 germanium diodes (A2CR1 through A2CR4) in a balanced bridge configuration. When the MODE selector switch is in the CONVERTED 10Hz-2MHz position, the mixer receives the 10 Hz to 2 MHz input signal from the input attenuator and the injection signal (2.5 to 4.5 MHz, 0.3 volt nominal) from the external VFO. The 2.5-MHz difference output signal is applied to the 2.5-MHz i-f amplifier. The VFO injection signal is balanced to a minimum in the output of the balanced mixer by means of BAL R control R18 and BAL C control C1. These components vary the resistive and reactive balance of the VFO injection signal so as to compensate for differences in diode characteristics and transformer T1 unbalance.

3-9. 2.5-MHz I-F AMPLIFIER. The 2.5-MHz i-f amplifier consists of grounded-base amplifier A3Q1, common emitter amplifier A3Q2, and emitter follower A3Q3. It amplifies the low level difference frequency output from the balanced mixer to the level required for a full-scale deflection on the associated spectrum analyzer CRT. Stage A3Q1, a low noise amplifier, matches the 75-ohm output impedance of balanced transformer T2. Overcoupled transformer A3T1 couples the output of A3Q1 to stage A3Q2, a high-gain amplifier. The overall gain of the 2.5-MHz i-f amplifier is controlled by A3R11, an adjustable resistor in the emitter circuit of A3Q2. The output of A3Q2 is applied through overcoupled transformer A3T2 to the base of emitter follower A3Q3. A low-pass filter circuit in the output of A3Q3 (A3L1 through L7 and A3C14 through C16) prevents spurious signals above 2.55 MHz from reaching the associated spectrum analyzer. The overall response of the i-f amplifier is within ±0.5 dB from 2.45 to 2.55 MHz. This 100kHz bandwidth is required to complement the 100-kHz bandwidth of the associated spectrum analyzer.

3-10. 3-MHz OSCILLATOR. The 3-MHz oscillator comprises stage A1A3Q1, a Pierce-type oscillator circuit. When the MODE selector switch is placed in the CONVERTED 10Hz-2MHz position, the 3-MHz oscillator is energized. The oscillator output is then applied through transformer A1A3T1, forward-biased diode A1A2CR3, capacitor A1A2C2, and VFO OUTPUT jack J2 to the associated spectrum analyzer.

3-11. DIODE SWITCHES. Diodes A1A1CR1 and CR2, and A1A2CR1 through CR3 are electronic switches that connect either the external VFO input and 3-MHz oscillator output to the balanced mixer and associated spectrum analyzer, respectively,

or the external VFO input to the spectrum analyzer. When the MODE selector switch is set to the CONVERTED 10Hz-2MHz position, diodes A1A1CR1, A1A2CR1, and A1A2CR3 are forward-biased and diodes A1A1CR2 and A1A2CR2 are back-biased. This causes the following to occur:

a. The external VFO input, present at VFO INPUT jack J3, is applied through A1A1CR1 and A1A1C1 to balanced mixer transformer T1.

b. The 3-MHz oscillator is energized and its output is applied through A1A2CR3, A1A2C2, and VFO OUTPUT jack J2 to the associated spectrum analyzer.

c. The external VFO input is disconnected from the VFO OUTPUT line. When the MODE selector switch is set to DIRECT (associated spectrum analyzer is being used only with the external VFO), diodes A1A1CR2 and A1A2CR2 are forward-biased, and diodes A1A1CR1, A1A2CR1, and A1A2CR3 are back-biased. This causes the following to occur:

a. The external VFO input, present at VFO INPUT jack J3, is applied through A1A1CR2, A1A1C2, A1A2C1, A1A2CR2, A1A2C2, and the VFO OUTPUT jack to the associated spectrum analyzer.

b. The external VFO input is disconnected from the balanced mixer.

c. The 3-MHz oscillator is de-energized and its output transformer A1A3T1 is disconnected from the VFO OUTPUT line.

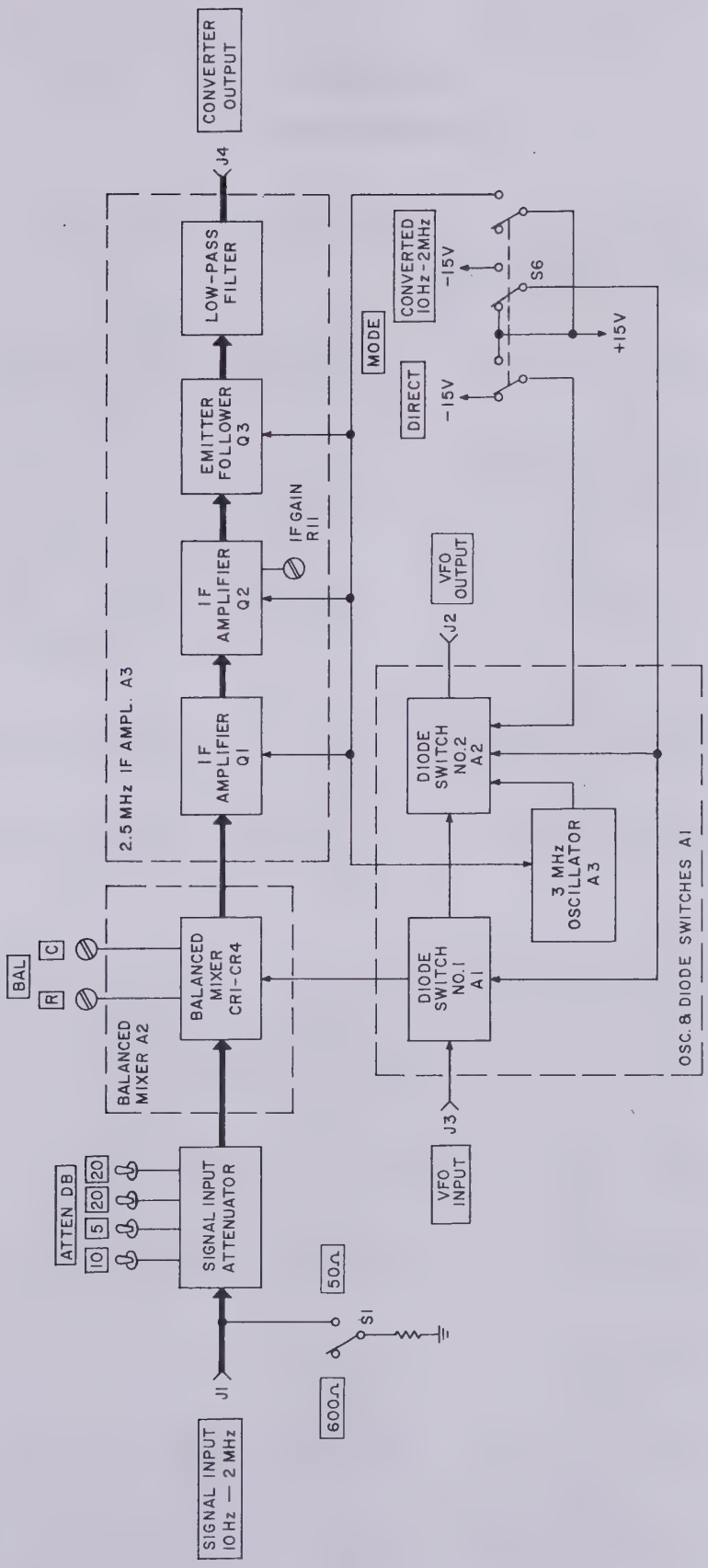


Figure 3-1. Converter, Block Diagram

SECTION IV
MAINTENANCE

4-1. GENERAL.

4-2. This section contains maintenance instructions for the Converter. No attempt should be made to repair internal components or make adjustments until the operator is thoroughly familiar with the information contained in this section.

4-3. The performance of the Converter may be checked using the minimum performance standards checks provided to determine whether the equipment is operating within published specifications. A systematic troubleshooting procedure to isolate troubles in the Converter and an alignment procedure to restore the equipment to proper operating condition after the required repairs have been effected are also included in this section.

4-4. TEST EQUIPMENT REQUIRED.

4-5. The test equipment required for the maintenance and alignment of the Converter is listed in table 4-1. Equipment having similar characteristics may be substituted for those listed in the table.

4-6. PRELIMINARY INSPECTION.

4-7. Preliminary inspection of the equipment is performed with the Converter removed from the main frame and without operating power applied. This type of check is designed to detect conditions that might otherwise lead to a breakdown. Frequent causes of premature failure are overheating due to improper ventilation, accumulation of dust and dirt and/or loose connections and fittings. Inspection is carried out with emphasis on finding evidence of these conditions.

4-8. COMPONENT LOCATION. The location of components mentioned in the inspection routines, alignment and troubleshooting procedures are illustrated in figures 4-1 and 4-2.

4-9. INSPECTION ROUTINES. Table 4-2 details the preliminary inspection routine for the equipment.

TABLE 4-1. TEST EQUIPMENT REQUIRED

Type of Equipment	Suggested Manufacturer Name and Model No.	Use
Signal Generator	Hewlett-Packard Model 651A	Provides input signal for test and calibration.
Attenuator, 50 ohm	Kay Model 30-0	Functions with signal generator to set level, and check attenuator calibration.
VTVM	RCA Model WV-98C	Voltage measurements.
Oscilloscope	Tektronix 531A with Type L plug-in unit	General waveform analysis.

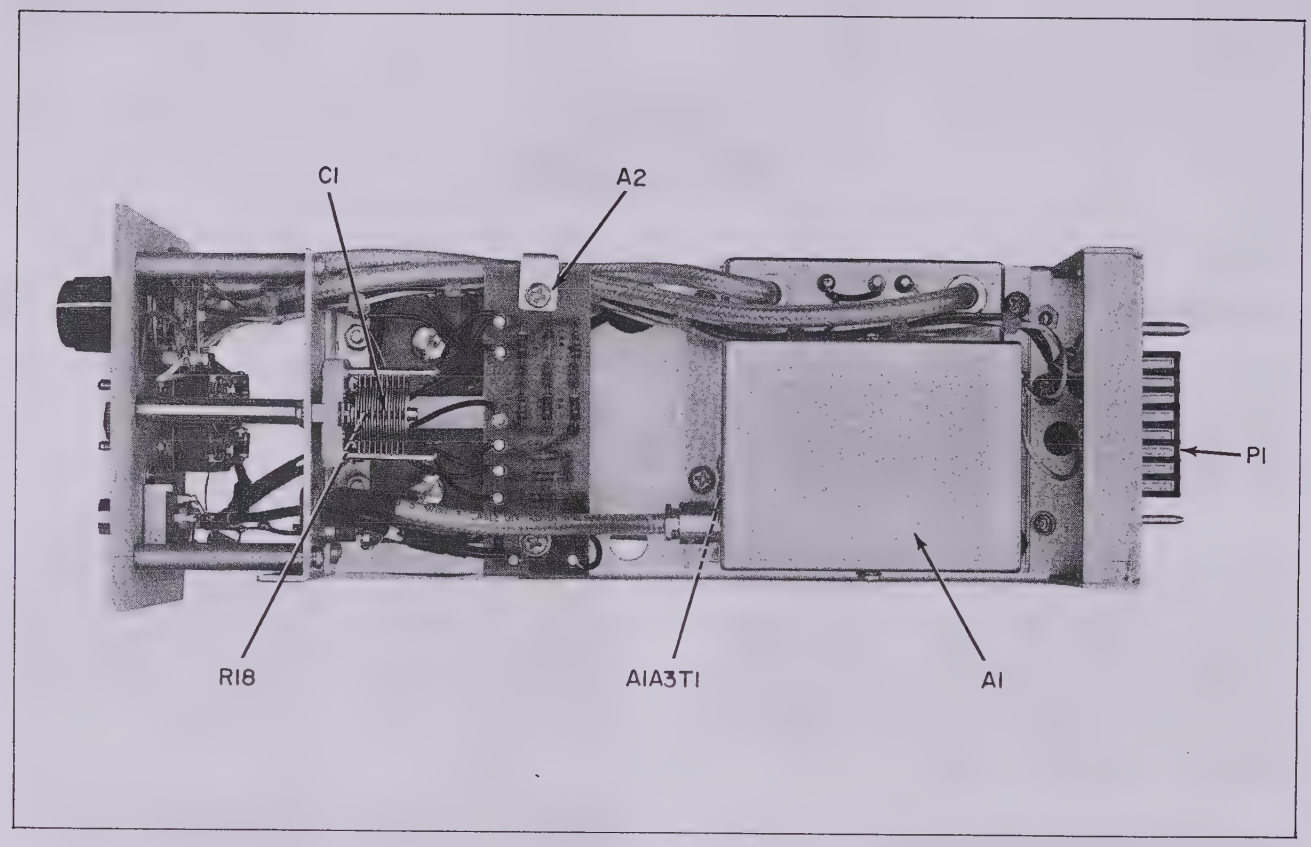


Figure 4-1. Converter, Top View

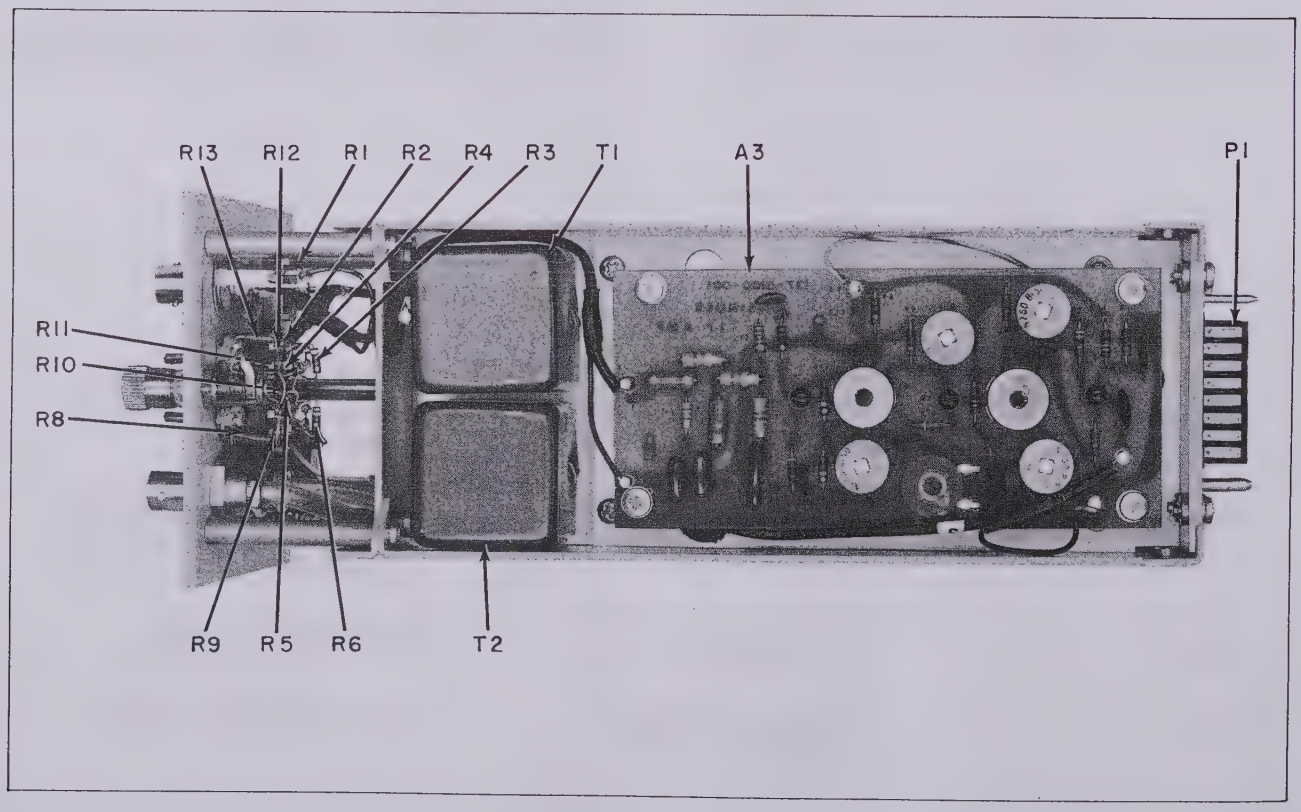


Figure 4-2. Converter, Bottom View

TABLE 4-2. PRELIMINARY INSPECTION ROUTINE

Item	Inspect for	Corrective Action
Connector P1 at rear of Converter	Looseness, bent or corroded contacts, signs of arcing	Clean contacts with cloth moistened with cleaning solvent (trichloroethylene or equivalent). Replace plug if damaged or corroded.
Converter case and panels	Dirt and corrosion	Clean with cloth moistened with cleaning solvent (trichloroethylene or equivalent).
Knobs, screws, connectors, clamps	Looseness	Tighten using appropriate torque so as not to strip threads.
Switches	Looseness	Tighten mounting screws or nut.
Wiring	Looseness	Resolder, recable, or reclamp.
	Frayed, worn, or missing insulation	Rewire as required.
Solder joints	Loose or cold solder connections; corrosion	Clean carefully and resolder.
Printed circuit boards	Loose components	Resolder loose components.
Resistors	Cracks, chipping, blistering, discoloration, and other signs of overheating	Replace resistor and ensure that overheating is not due to other defective components.
Capacitors	Leaks, bulges, signs of aging	Replace capacitor.
	Loose mounting bracket	Tighten nuts or screws holding bracket.
Switch contact	Dirt, dust, and/or corrosion	Clean with cloth, aerosol spray, syringe or camelhair brush using trichloroethylene or equivalent.
	Bent or broken contacts	Replace switch wafer or assembly.

4-10. MINIMUM PERFORMANCE STANDARDS.

4-11. The minimum performance standards checks listed in table 4-3 provide a rapid, convenient means of ascertaining proper Converter operation. These checks are performed with the Converter operating in the Model SSB-50 Single Sideband Analyzer System (or equivalent). The quality of these checks pre-supposes that all the units of the SSB-50 (except the Converter) are operating within acceptance limits; thus, procedures in the technical manuals for these units (MF-5, MF-50, TTG-3, RF-8, and CA-5) should be performed prior to performing the checks. Figure 4-3 illustrates the equipment setup required to perform the minimum performance checks. Before performing these checks, position the control of the SSB-50 system as indicated below and check the mixer balance as outlined in paragraph 4-12.

a. On the Converter:

MODE switch	CONVERTED 10Hz-2MHz
50 Ω -600 Ω switch	50 Ω
ATTEN DB switches	All in the down position

b. On the RF-8:

RANGE switch	2.0 - 4.5
Tuning Control	Rotated until a 0.0 tuning dial MHz indication is obtained on yellow band of 2.0 - 4.5 frequency scale.

c. On the TTG-3:

600 Ω TERMINATION switch	OUT
OUTPUT control	A & B
All other controls	Present position

d. On the MF-50:

POWER switch	OFF

e. On the CA-5:

FREQ SCALE-Hz/DIV control	VAR
SWEEP RATE-Hz control	1.5 - 30
VARIABLE control	Maximum CW
ATTENUATOR switches	OUT position
GAIN control	Maximum CW
IF ATTENUATOR switch	20 dB
AMPLITUDE SCALE switch	LOG
TEST SIGNAL-Hz control	OFF
SWEEP MODE control	NORMAL

f. On the MF-5:

SCALE ILLUMINATION control	PWR OFF
All other controls	Present position

4-12. Check the mixer balance as follows:

a. Rotate the SCALE ILLUMINATION control on the Model MF-5 Main Frame clockwise until the CRT graticule illuminates.

b. Set the POWER switch on the Model MF-50 Main Frame to ON and allow the system a 30-minute warmup period.

c. Connect the plug of the 6-inch patch cable that connects to the CONVERTED OUTPUT jack on the Converter to the SIGNAL INPUT jack on the CA-5 Panalyzor.

d. Rotate the tuning control on the RF-8 Tuning Head until the zero pip appears under the CF line engraved on the CA-5 graticule. The amplitude of the zero pip should be half-scale LOG or less. If not, adjust the BAL C and R screwdriver controls on the Converter front panel to minimize zero pip deflection.

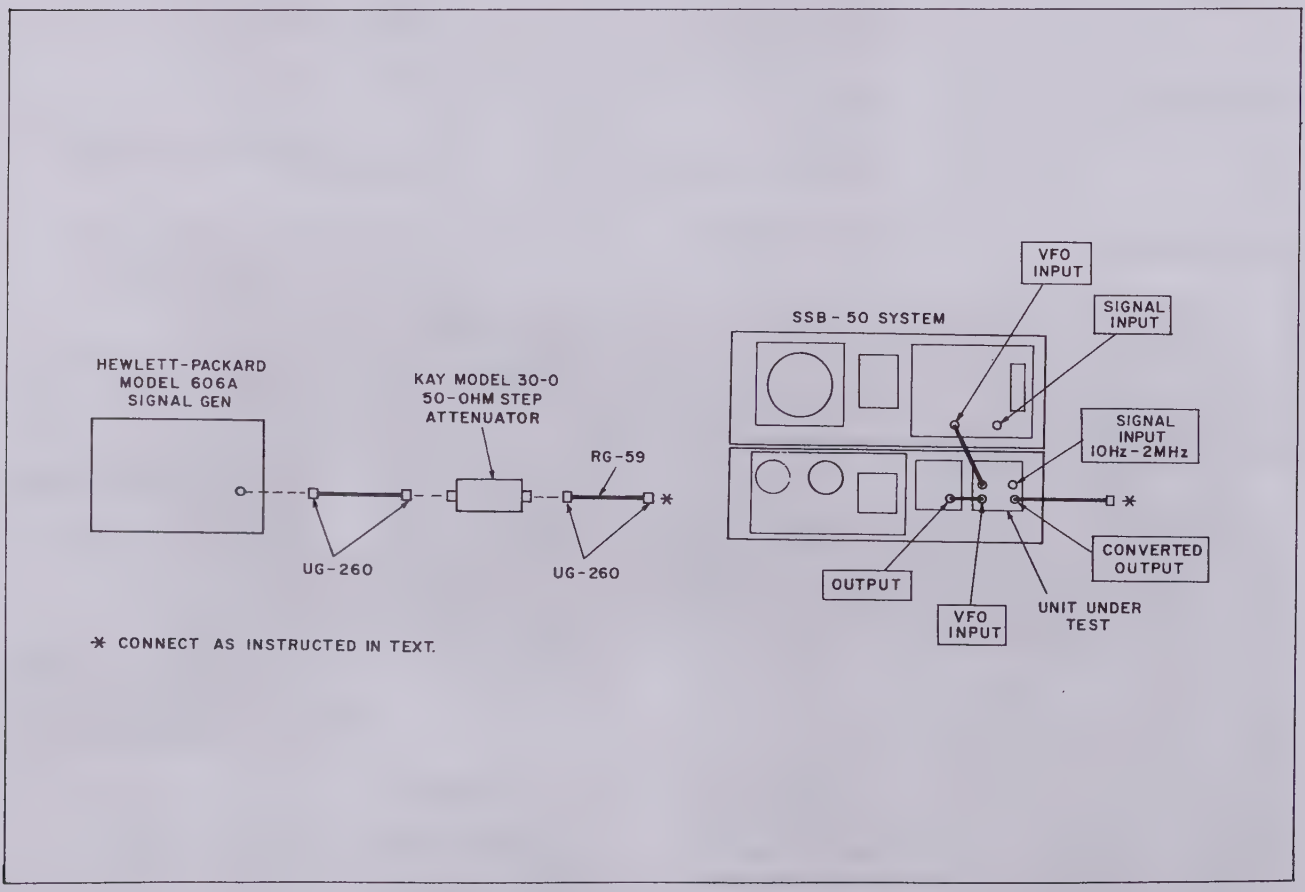


Figure 4-3. Minimum Performance Standards, Test Setup

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS

Step	Purpose	Procedure	Acceptable Indication
1	To check sensitivity of Converter.	a. Set the MODE selector switch on the Converter to DIRECT and disconnect the CONVERTED OUTPUT jack on the Converter from the SIGNAL INPUT jack on the CA-5. Connect the signal generator 50-ohm step attenuator to the SIGNAL INPUT jack on the CA-5, set the generator frequency to 3 MHz and output level to 200* microvolts, and set the 50 ohm step attenuator to 0 dB. Set the AMPLITUDE SCALE switch on the CA-5 to LIN, and rotate the tuning control on the RF-8 until a 3.0 MHz indication (1.0 MHz on yellow band) is obtained on the MHz tuning dial. Observe a full-scale LIN signal pip on the CRT. b. Set the MODE selector switch on the Converter to CONVERTED 10Hz-2MHz and disconnect the signal generator 50-ohm step attenuator from the SIGNAL INPUT jack on the CA-5. Connect the CONVERTED OUTPUT jack on the Converter to the SIGNAL INPUT jack on the CA-5. Connect the signal generator 50-ohm step attenuator to the SIGNAL INPUT 10Hz-2MHz jack on the Converter, and set the signal frequency to 1 MHz. With the RF-8 MHz tuning dial set at 1.0 MHz on yellow band of the 2.0-4.5 frequency scale, adjust the output level of the signal generator, if required, to obtain a full-scale LIN signal pip on the CRT. Note output level of signal generator.	Output level of signal generator is 200* microvolts or less for a full-scale pip.
2	To check frequency response (flatness) of Converter.	a. Set the FREQ SCALE-Hz/DIV control on the CA-5 to 1.4K and the GAIN control to mid position. Set the signal generator to 1 kHz, and rotate the RF-8 tuning control until a signal pip	Level of input signal required for full-scale deflection at any frequency does not vary more than 2 dB from level required at any other frequency.

(Cont'd)

*When using the Model REC-2 in an SSB-50-1 System, set generator output level to 150 microvolts. Acceptable output level of generator should be 150 microvolts when REC-2 is used in SSB-50-1 System.

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
2 (Cont'd)		appears under the CF line on the CRT graticule. Adjust the signal generator output level until a full-scale deflection is obtained on the CRT. Note the indication on the signal generator output meter. b. Repeat step a above for an input signal of 10 kHz. c. Set the FREQ SCALE-Hz/DIV control on the CA-5 to VAR. With the same input signal as in b above adjust the GAIN control on the CA-5 to obtain a full-scale signal pip on the CRT. d. With FREQ SCALE-Hz/DIV control at VAR, repeat step a above for input signals of 500 kHz, 1 MHz, 1.5 MHz and 2 MHz.	
3	To check accuracy of input attenuators.	Set the signal generator frequency to 1 MHz, and rotate the tuning control on the RF-8 until a signal pip appears under the CF line on the CRT graticule. Insert 55 dB of attenuation in the signal generator 50-ohm step attenuator and set the ATTENUATOR switches on the CA-5 to their OUT position. Adjust the signal generator output level until a full-scale deflection is obtained on the CRT. Set in 20, 20, 10, and then 5 dB of attenuation in the Converter by operation of the ATTEN DB switches, while decreasing the attenuation of the 50-ohm signal generator attenuator by a corresponding amount.	Input signal produces exactly full-scale deflection and deflection variation thereafter does not exceed ±10 percent from step to step.
4	To check harmonic and intermodulation distortions.	a. Disconnect the signal generator 50-ohm step attenuator from the SIGNAL INPUT 10Hz-2MHz jack on the Converter, set 50 Ω - 600 Ω switch to 600 Ω and connect a patch-cable between the OUTPUT jack on the TTG-3 and the SIGNAL INPUT 10Hz-2MHz jack on	a. All harmonics, intermodulation, and spurious signals fall below -40 dB graduation on CRT (-60 dB* below signal amplitude).

(Cont'd)

*-70dB below signal amplitude should be measured when checking harmonic and intermodulation distortions in an SSB-50-1 System.

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
4 (Cont'd)		the Converter. Set ATTEN DB switches on the Converter to the down position. On the TTG-3, select a channel A frequency of 2.5 kHz and a channel B frequency of 4.5 kHz; set the ATTENUATOR DB controls to 58 dB. On the CA-5, set the FREQ SCALE-Hz/DIV control to 350, the GAIN control maximum CW, and the AMPLITUDE SCALE switch to LOG. Rotate the tuning control on the RF-8 until 2.5- and 4.5-kHz signal pips appear on CRT. Set the ATTENUATOR switches on the CA-5 to obtain a full-scale LOG deflection* on the CRT and then set the IF ATTENUATOR switch to 0 dB.** Rotate the tuning control on the RF-8 so that the 4.5-kHz signal pip (left) moves to the extreme right side of the CRT screen.	
		b. Rotate the tuning control on the RF-8 so that the 4.5-kHz signal pip moves to the extreme left side of the CRT screen.	b. Same as step a.

*When making this check in an SSB-50-1 System, 10 DB of ATTENUATOR setting (on CA-5-1) must be used to obtain full scale log deflection.

**Set IF ATTENUATOR switch to 0 dB, and 2 and 8 DB ATTENUATOR switches (on the CA-5-1) to OUT when using the REC-2 in an SSB-50-1 System.

4-13. POWER SUPPLY CHECK.

4-14. Before proceeding with the systematic troubleshooting of the Converter, the +15vdc and -15vdc input voltages from the main frame should be checked. This check will usually determine whether abnormal d-c voltages are causing the malfunction. To check these voltages, remove the Converter from the main frame and connect d-c power to it using the service cable provided with the SSB-50 system. Remove the top cover and use the RCA Model WV-98C VTVM to measure the +15vdc supply voltage between pin P1-2 (positive) and P1-9 (negative); and the -15vdc supply voltage between P1-11 (negative) and P1-9 (positive).

4-15. SYSTEMATIC TROUBLE LOCALIZATION.

4-16. Three possible troubles are presented in table 4-4 to illustrate a systematic approach to the isolation of a trouble in the Converter. This procedure is performed with the Converter operating in an SSB-50 system and connected to the Model MF-50 Main Frame via the supplied service cable. Note that full use is made of the maintenance information in the manual (e.g., the block diagram, the voltage chart, and the schematic).

4-17. The three problems that will be considered are:

a. Weak or no signal on the CRT of the CA-5 when only in the CONVERTED 10Hz-2MHz mode of operation.

b. Weak or no signal on the CRT of the CA-5 when only in the DIRECT mode of operation.

c. Weak or no signal on the CRT of the CA-5 when in either the CONVERTED 10Hz-2MHz or DIRECT mode of operation.

TABLE 4-4. SYSTEMATIC TROUBLE LOCALIZATION

No.	Symptom	Test Procedure	If Indication Is Normal	If Indication Is Abnormal
1	Weak or no signal on the CRT of the CA-5 when only in the CONVERTED 10Hz-2MHz mode of operation.	a. Connect a signal generator to the SIGNAL INPUT jack on the CA-5. Set the generator frequency to 2.5 MHz and adjust its output to 200 microvolts. With the ATTENUATOR switches set to the OUT position, the IF ATTENUATOR switch set to 20 dB, and the GAIN control set maximum CW on the CA-5, a full-scale signal pip deflection should be obtained on the CRT of the MF-5	a. Go to step b.	a. Troubleshoot 3-MHz oscillator stage A1A3Q1 and associated circuitry.
		b. Disconnect the signal generator from the CA-5 and connect the CONVERTED OUTPUT jack on the Converter to the SIGNAL INPUT jack on the CA-5. Apply a 2.5-MHz, 12-microvolt signal between terminal B of transformer T2 and ground. With the ATTENUATOR switches set to the OUT position, the IF ATTENUATOR switch set to 20 dB, and the GAIN control set maximum CW on the CA-5, a full-scale signal pip deflection should be obtained on the CRT of the MF-5.	b. Troubleshoot the balanced mixer and associated input circuitry.	b. Troubleshoot the 2.5-MHz i-f amplifier.
2	Weak or no signal on the CRT of the MF-5 when only in DIRECT mode of operation.	a. Remove power from the system and check the VFO input circuitry.	a. Go to b.	a. Replace defective component(s).
		b. Check MODE switch S6 (contacts 3 and 6).		b. Replace defective switch.
3	Weak or no signal on the CRT of the MF-5. when in either the CONVERTED 10Hz-2MHz or DIRECT mode of operation.	Remove power from the system and check MODE switch S6 (contacts 1 and 4).	Check A1A1L1, A1A1L2, A1A2R3, A1A2C2, A1A2L1 and A1A2C3.	Replace defective switch.

4-18. ALIGNMENT AND ADJUSTMENT PROCEDURES.

4-19. Paragraphs 4-21 through 4-23 contain the complete alignment and adjustment procedures for the Converter. Alignment of the Converter may be required after a component has been replaced in an adjustable circuit or after extreme component aging. The need for realignment will show up during the minimum performance standards checks.

4-20. Remove the Converter from its main frame and remove its top and bottom covers. Energize the unit with the supplied service cable.

4-21. 3-MHz OSCILLATOR ALIGNMENT. To align the 3-MHz oscillator, proceed as follows:

a. Remove the cover from the 3-MHz oscillator and diode switches assembly A1. Rotate the tuning slug of transformer A1A3T1 until the tuning slug screw is 1/2-inch out of the coil form.

b. Replace the cover on assembly A1 and set the MODE selector switch to the CONVERTED 10Hz-2MHz position.

c. With the VFO OUTPUT jack of the Converter connected to the VFO INPUT jack on the CA-5, apply a 2.5-MHz, approximately 200-microvolt signal to the SIGNAL INPUT jack on the CA-5. Adjust the generator frequency and amplitude as required, to obtain a signal pip under the CF line on the CRT graticule.

d. Remove the panel plug on the side of assembly A1. Adjust the tuning slug of A1A3T1 in a counterclockwise direction to peak the signal pip on the CRT. Further counterclockwise rotation of the tuning slug will cause the signal pip to disappear. When this occurs, tune the slug in a clockwise direction to cause the signal pip to reappear on the CRT; then continue adjusting the tuning slug in a clockwise direction to reduce the signal pip by one division from its peak amplitude position.

Note

The total clockwise rotation of the tuning slug, from the point that the signal pip disappears on the CRT, is approximately 3 full turns.

4-22. 2.5-MHz I-F AMPLIFIER ALIGNMENT. To align the 2.5-MHz i-f amplifier, proceed as follows:

a. Set the MODE selector switch to the CONVERTED 10Hz-2MHz position.

b. Set i-f gain adjust A3R11 to the midposition of its adjustment range.

c. Connect a signal generator between terminal B of transformer T2 and ground.

d. Set the signal generator frequency to 2.5 MHz and adjust for a 12-microvolt output. With the Converter properly interconnected to the RF-8 and CA-5, observe that a signal pip appears under the CF line of the CRT graticule.

e. Adjust trimmers A3C5 and A3C11 to peak the signal pip on the CRT. Then, adjust the signal generator output level for a full-scale signal pip on the CRT.

f. Set the signal generator frequency to 2.550 MHz and adjust trimmer A3C10 to peak the signal pip on the CRT.

g. Set the signal generator frequency to 2.445 and adjust trimmer A3C4 to peak the signal pip on the CRT.

h. Repeat steps e through g until a ±5 percent (±0.5 division) flatness is obtained over the frequency range of 2.450 to 2.550 MHz. Note that the CA-5 may have a ±0.5 dB variation in response over this frequency range. Do not include its response in the determination of the 2.5-MHz i-f amplifier flatness.

i. If the low or high frequency end points drop off excessively, peak A3C10 at 2.555 MHz and A3C4 at 2.440 MHz. Then repeat step e and this step until no further adjustment is required.

j. After performing step i, check for the ±5 percent flatness over the frequency range from 2.450 to 2.550 MHz. When the i-f amplifier is properly aligned, a signal generator output level of approximately 12 microvolts should produce a full-scale signal pip on the CRT of the MF-5.

4-23. 2.5-MHz I-F AMPLIFIER GAIN ADJUSTMENT. To adjust the gain of the 2.5-MHz i-f amplifier, proceed as follows:

a. Set the MODE selector switch to the CONVERTED 10Hz-2MHz positions and the ATTEN DB switches to their down position.

b. With the Converter properly interconnected to the CA-5 and RF-8, check the mixer balance as outlined in paragraph 4-12.

c. Apply a 1-MHz, 200-microvolt signal to the SIGNAL INPUT 10Hz-2MHz jack on the Converter. (Tune the RF-8 to 1 MHz.)

d. With the ATTENUATOR switches in the OUT position, the IF ATTENUATOR switch to 20 dB, and the GAIN control fully CW on the CA-5, adjust i-f gain adjust A3R11 for a full-scale LIN signal pip deflection on the CRT.

4-24. TYPICAL VOLTAGE MEASUREMENTS.

4-25. Voltage measurements for each of the transistor stages in the Converter are given in table 4-5. These voltages were obtained using an RCA Model WV-98C VTVM, with no signal applied to the Converter and the MODE selector switch set to the CONVERTED 10Hz-2MHz position.

TABLE 4-5. VOLTAGE MEASUREMENTS

Reference Designation	Transistor Type	Terminal Voltage			Notes
		Base	Emitter	Collector	
A1A3Q1	2N3638A	+12.2	+12.2	+ 2.75	
A3Q1	2N3565	+ 3.0	+ 2.3	+11.0	
A3Q2	2N3565	+ 2.95	+ 2.3	+10.9	Depends on setting of A3R11
A3Q3	2N3565	+ 7.2	+ 6.6	+15.0	

SECTION V
SCHEMATIC DIAGRAMS

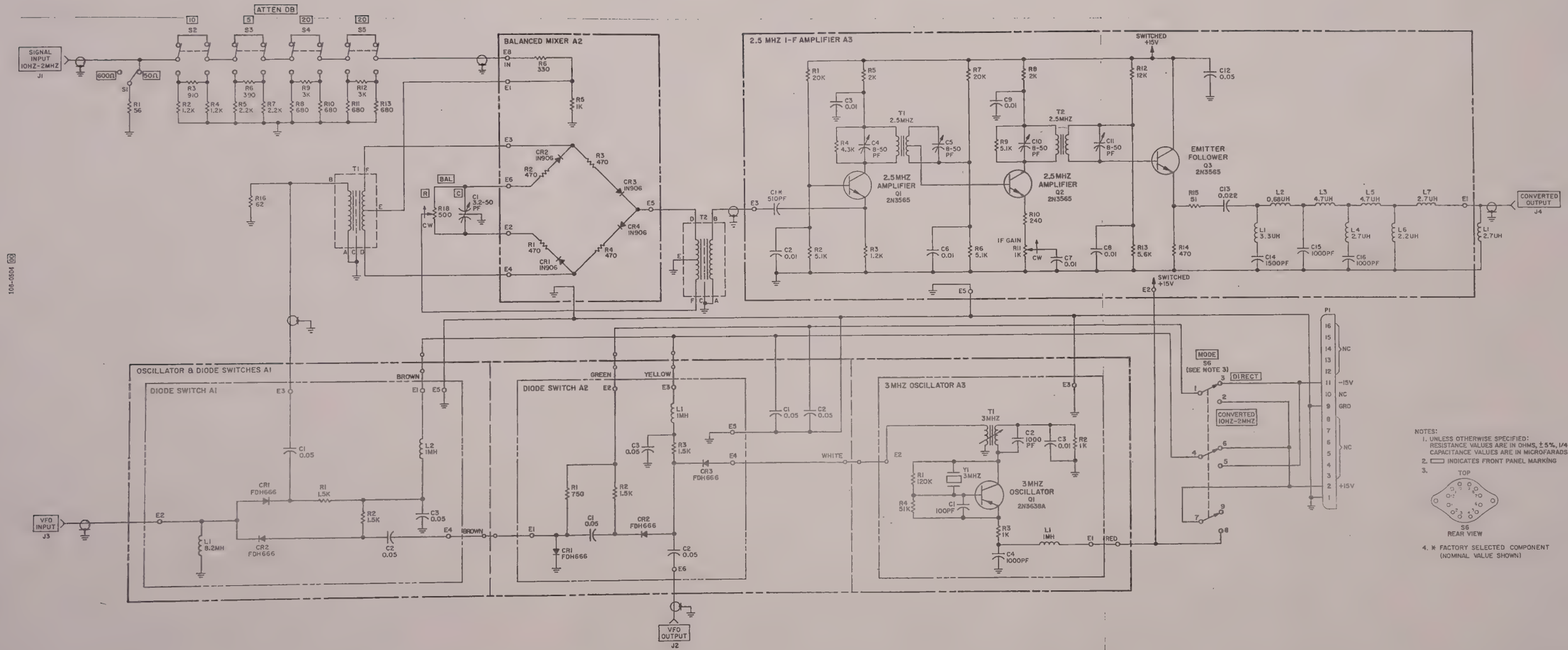


Figure 5-1. Converter, Schematic Diagram

SECTION VI
PARTS LIST

6-1. INTRODUCTION.

6-2. This parts list section includes all pertinent data necessary to locate, identify, and procure additional parts for the equipment. Parts are listed alpha-numerically by reference symbol and include all replaceable items such as electronic, electro-mechanical, and mechanical parts of the equipment. In some cases, values, ratings and manufacturer sources shown are nominal and variations may be found. Satisfactory replacement may be made with either the listed component or an exact replacement of the part(s) removed from the equipment.

6-3. ORDERING INFORMATION.

6-4. The following instructions will aid in ordering parts from the Parts Lists, table 6-2.

a. Address all inquiries or orders to:

CUSTOMER SERVICE
Department 500-1
The Singer Company
Metrics Division
915 Pembroke Street
Bridgeport, Connecticut 06608

b. Include the following information:

1) Model and Serial Number of instrument.
2) Singer Part Number.
3) Reference Symbol Number.
4) Description (as shown on list).

6-5. HOW TO USE THE PARTS LIST.

6-6. Paragraphs 6-7 through 6-11 describe the use and meaning of the five columns included in the parts list (see figure 6-1).

6-7. REF SYMBOL COLUMN. The Ref Symbol Column (1, figure 6-1) contains an alpha-numerical listing of parts as they appear on equipment chassis, illustration, or schematic. The reference designation identifies the parts as to their component function in the instrument.

6-8. DESCRIPTION COLUMN. The Description Column (2, figure 6-1) contains the identification of component parts including all pertinent specifications and Singer part number. When the description column is used for a part which is identical to a part which has already been described; SAME AS (3) is used along with the reference symbol of the previously used part. In these instances, columns 3, 4, 5 are left blank. When the description column is used for a reference symbol for which no part exists; NOT USED (4) is placed in the column. In these instances, columns 3, 4, 5, are left blank.

6-9. MANUFACTURER'S PART NUMBER COLUMN. The Manufacturer's Part Number column (5, figure 6-1) contains the part number as designated by the manufacturer of the part.

6-10. MFR'S CODE COLUMN. The Mfr's Code column (6, figure 6-1) references the manufacturer by an assigned code number as listed in Federal Supply Code Handbook H4-2. For manufacturers not listed in H4-2, a letter code will be assigned. Table 6-1 includes the manufacturer and his code designation.

6-11. MAINT QTY COLUMN. The Maint Qty column (7, figure 6-1) contains the number of additional components recommended to keep the equipment at an optimum performance level. The recommended number of components in the Maint Qty column is based on 2000 hours of equipment operation.

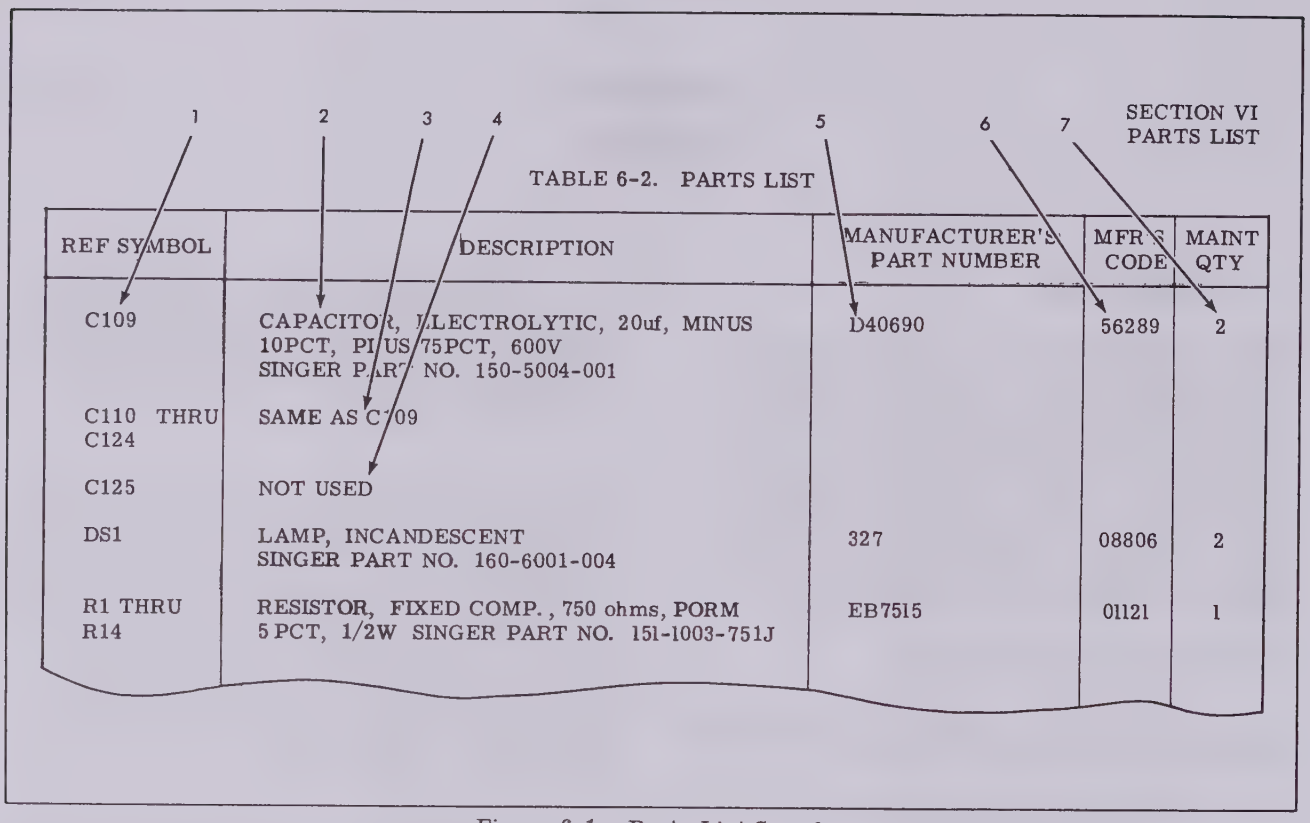


Figure 6-1. Parts List Sample

TABLE 6-1. MANUFACTURER'S CODE

Number	Name
01121	Allen-Bradley Co., Milwaukee, Wis.
02660	Amphenol-Borg Electronics Corp. Maywood, Ill.
13715	Fairchild Camera and Instrument Corp. Semiconductor Division San Rafael, Calif.
16665	The Singer Co., Metrics Division Bridgeport, Conn.
56289	Sprague Electric Co. North Adams, Mass.
71450	CTC Corp., Elkhart, Ind.
71590	Centralab Division of Globe-Union Inc. Milwaukee, Wis.
72136	Electro-Motive Mfg. Co. Inc. Willimantic, Conn.
72982	Erie Technological Products Inc. Erie, Pa.
76487	James Millen Mfg. Co. Inc. Malden, Mass.
78429	Speer Carbon Co. St. Marys, Pa.
79727	Continental-Wirt Electronics Corp. Philadelphia, Pa.
81349	Military Specifications
82142	Jeffers Electronics Division of Speer Carbon Co. DuBois, Pa.
91737	Gremar Mfg. Co. Inc. Wakefield, Mass.
95146	Alco Electronics Manufacturing Co. Lawrence, Mass.
98291	Sealectro Corp. Mamaroneck, N.Y.
99848	Wilco Corp. Indianapolis, Ind.

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
C1	CAPACITOR,VARIABLE, 3.2 TO 50 PF	134-0015-001	16665	1
J1	CONNECTOR,JACK SINGER PART NO.168-4006-001	UG1094/U	81349	1
J2 AND	CONNECTOR,JACK SINGER PART NO.139-0019-001	13762	91737	1
J4	SAME AS J1			
L1	CHOKE, 2.7UH SINGER PART NO. 556146-778	4436-5K	78429	1
P1	CONNECTOR,PLUG SINGER PART NO. 556166-045	26-159-16	02660	1
R1	RESISTOR,FIXED,COMP., 56 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-560J	CB5605	01121	1
R2	RESISTOR,FIXED,COMP., 1.2K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-122J	CB1225	01121	1
R3	RESISTOR,FIXED,COMP., 910 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-911J	CB9115	01121	1
R4	SAME AS R2			
R5	RESISTOR,FIXED,COMP., 2.2K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-222J	CB2225	01121	1
R6	RESISTOR,FIXED,COMP., 390 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-391J	CB3915	01121	1
R7	SAME AS R5			
R8	RESISTOR,FIXED,COMP., 680 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-681J	CB6815	01121	3
R9	RESISTOR,FIXED,COMP., 3K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-302J	CB3025	01121	1
R10 AND R11	SAME AS R8			
R12	SAME AS R9			
R13	SAME AS R8			
R16	RESISTOR,FIXED,COMP., 62 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-620J	CB6205	01121	1
R18	RESISTOR,VARIABLE, 500 OHMS,PORM 10 PCT,1/2W	151-0001-048	16665	1
S1	SWITCH,SLIDE,1 POL.,2 POS. SINGER PART NO. 556146-415	G-123	79727	1
S2 THRU S5	SWITCH,TOGGLE,DPDT SINGER PART NO. 133-0069-001	MST-205-N	95146	1
S6	SWITCH,ROTARY	133-0068-001	16665	1
T1 AND T2	TRANSFORMER	556026-336	16665	1
A1C1 AND A1C2	CAPACITOR,FIXED,CERAMIC DISC., 0.05 UF,25V SINGER PART NO. 556146-417	5855-000Y5V503Z	72982	2
A1A1	DIODE SWITCH ASSY	103-1117-001	16665	1
A1A1CR1 AND A1A1CR2	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556146-880	FDH666	13715	1

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A1A1C1 THRU A1A1C3	SAME AS A1C1			
A1A1L1	COIL,RF, 8.2 MH SINGER PART NO. 556012-101	216-11	99848	1
A1A1L2	CHOKE, 1MH. SINGER PART NO. 556012-196	J300-1000	76487	1
A1A1R1 AND A1A1R2	RESISTOR,FIXED,COMP., 1.5K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-152J	CB1525	01121	4
A1A2	DIODE SWITCH ASSY	103-1116-001	16665	1
A1A2CR1 THRU A1A2CR3	SAME AS A1A1CR1			
A1A2C1 THRU A1A2C3	SAME AS A1C1			
A1A2L1	SAME AS A1A1L2			
A1A2R1	RESISTOR,FIXED,COMP., 750 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-751J	EB7515	01121	1
A1A2R2 AND A1A2R3	SAME AS A1A1R1			
A1A3	3 MHZ OSC. ASSY	103-1096-001	16665	1
A1A3C1	CAPACITOR,FIXED,DIPPED MICA, 100 PF, PORM 5 PCT,500V SINGER PART NO. 150-2002-101EJO	DM15E101J0500WV4CR	72136	1
A1A3C2	CAPACITOR,FIXED,DIPPED MICA, 1000 PF, PORM 5 PCT,500V SINGER PART NO. 150-2002-102EJO	DM15E102J0500WV4CR	72136	1
A1A3C3	CAPACITOR,FIXED,CERAMIC DISC, 0.01 UF,250V SINGER PART NO. 556060-146	DA140-172B	71590	1
A1A3C4	CAPACITOR,FIXED,CERAMIC DISC, 1000 PF PORM 10 PCT,1000V SINGER PART NO. 556060-046	DD-102	71590	1
A1A3L1	SAME AS A1A1L2			
A1A3Q1	SEMICONUDCTOR DEVICE,DIODE SINGER PART NO. 556146-401	2N3638A	81349	1
A1A3R1	RESISTOR,FIXED,COMP., 120 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-124J	CB1245	01121	1
A1A3R2 AND	RESISTOR,FIXED,COMP., 1K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-102J	CB1025	01121	1
A1A3R4	RESISTOR,FIXED,COMP., 51K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-513J	CB5135	01121	1
A1A3T1	3 MHZ OSCILATOR COIL	132-0192-001	16665	1
A1A3XY1	SOCKET,CRYSTAL	556024-122	16665	1
A1A3Y1	CRYSTAL,3 MHZ	556025-018	16665	1
A2	BALANCE MIXER ASSY	103-1118-001	16665	1
A2CR1 THRU A2CR4	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556118-168	IN906	81349	1

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A2R1 THRU A2R4	RESISTOR,FIXED,COMP., 470 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 150-1002-471J	CB4715	01121	1
A2R5	SAME AS A1A3R2			
A2R6	RESISTOR,FIXED,COMP., 330 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-331J	CB3315	00121	1
A3	2.5 MHZ I.F. ASSY	103-1120-001	16665	1
A3C1	FACTORY SELECTED			
A3C2 AND A3C3	SAME AS A1A3C3			
A3C4 AND A3C5	CAPACITOR,VARIABLE, 8 TO 50 PF SINGER PART NO. 556122-065	557-091-U2P034R	72982	1
A3C6 THRU A3C9	SAME AS A1A3C3			
A3C10 AND A3C11	SAME AS A3C4			
A3C12	SAME AS A1C2			
A3C13	CAPACITOR,FIXED,CERAMIC DISC., 0.022 UF, PLUS 80 PCT,MINUS 20 PCT,25V SINGER PART NO. 556060-105	19C383	56289	1
A3C14	CAPACITOR,FIXED,DIPPED MICA, 1500 PF, PORM 5 PCT,500V SINGER PART NO. 150-2003-152FJO	DM19F152J0500WV4CR	72136	1
A3C15 AND A3C16	SAME AS A1A3C2			
A3L1	CHOKE, 3.3 UH SINGER PART NO. 556146-419	4436-6K	78429	1
A3L2	CHOKE, 6.8 UH SINGER PART NO. 556146-777	4426-4K	78429	1
A3L3	CHOKE, 4.7 UH SINGER PART NO. 556146-141	4436-8K	78429	1
A3L4	SAME AS L1			
A3L5	SAME AS A3L3			
A3L6	CHOKE, 2.2 UH SINGER PART NO. 556149-420	4436-4K	78429	1
A3L7	SAME AS L1			
A3Q1 THRU A3Q3	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556146-254	2N3565	81349	1
A3R1	RESISTOR,FIXED,COMP., 20K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-203J	CB2035	01121	1
A3R2	RESISTOR,FIXED,COMP., 5.1K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-512J	CB5125	01121	1
A3R3	SAME AS R2			
A3R4	RESISTOR,FIXED,COMP., 4.3K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-432J	CB4325	01121	1
A3R5	RESISTOR,FIXED,COMP., 2K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-202J	CB2025	01121	1

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A3R6	SAME AS A3R2			
A3R7	SAME AS A3R1			
A3R8	SAME AS A3R5			
A3R9	SAME AS A3R2			
A3R10	RESISTOR,FIXED,COMP., 240 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-241J	CB2415	01121	1
A3R11	RESISTOR,VARIABLE,1K OHMS,PORM 30 PCT,1/8W SINGER PART NO. 556056-121	U201R102B	71450	1
A3R12	RESISTOR,FIXED,COMP., 12K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-123J	CB1235	01121	1
A3R13	RESISTOR,FIXED,COMP., 5.6 K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-562J	CB5625	01121	1
A3R14	SAME AS A2R1			
A3R15	RESISTOR,FIXED,COMP., 51 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-510J	CB5105	01121	1
A3T1	TRANSFORMER,I.F.	132-0215-001	16665	1
A3T2	TRANSFORMER I.F.	132-0195-001	16665	1

INSTRUCTION MANUAL

TWO-TONE AUDIO GENERATOR

MODEL TTG-3

Serial No. _____

Instruction Manual No. 110-5033

SINGER
INSTRUMENTATION

THE SINGER COMPANY • INSTRUMENTATION DIVISION

Creative Products for Test, Measurement, Analysis, Calibration

ADDENDUM

for

TWO-TONE AUDIO GENERATOR
MODEL TTG-3

1. In figure 5-1:

   a. Delete capacitors A4C16 and A4C18.

   b. Change the values of capacitors A4C3 and A4C9 from 0.0024 to 0.0022.

2. In table 6-2:

   a. Change the entry for "A4C15 THRU A4C18" to read "A4C15."

   b. Add an entry for A4C17. The description is to read "SAME AS A4C15."

   c. Change the description of A4C3 to read: "CAPACITOR,FIXED, DIPPED MICA, 2200 PF, PORM 5 PCT, 500 V, SINGER PART NO. 150-2003-222FJO.

   d. Change the manufacturer's part number for A4C3 to read: DM19F222JO500WV4CR

   e. Change the manufacuter's code for A4C3 to read "72136."

Addendum No. 486
(00 to 01)

ADDENDUM

for

MODEL TTG-3 & TTG-3/GD

Make the following changes to the List of Replaceable Parts.

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A4R7	RESISTOR, FIXED, PREC., 241K OHMS, PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B2413F	C1/2E241KOHM PORM 1 PCT	12126	1
A4R9	RESISTOR, FIXED, PREC., 128K OHMS, PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B1283F	C1/2E128KOHM PORM 1 PCT	12126	1
A4R10	RESISTOR, FIXED, PREC., 100K OHMS, PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B1003F	C1/2E100KOHM PORM 1 PCT	12126	1

ADDENDUM

for

MODEL TTG-3
(Effective on Equipment Serial Number U10282 and up)

I. PURPOSE.

To reflect component changes.

II. ADDENDUM.

a. Delete "80924 - Bourns Inc., Riverside, Calif." from table 6-1.

b. Incorporate the following changes into table 6-2.

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A4R28 and A4R29	RESISTOR, VARIABLE, 50K OHMS SINGER P/N 556147-257	NP503M	01121	1

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Figure 1-1. Model TTG-3 Two-Tone Audio Generator

SECTION I
INTRODUCTION

1-1. GENERAL.

1-2. This instruction manual provides operating and maintenance instructions for the PANORAMIC* Two-Tone Audio Generator, Model TTG-3 (hereafter referred to as the Generator), manufactured by The Singer Company, Metrics Division. Included in the manual are a general description of the Generator, installation and operating instructions, theory of operation, maintenance information and data, a schematic diagram and a repair parts list. The Generator is illustrated in figure 1-1.

1-3. The information contained in this manual refers to the standard version of the Generator and is current only to the date of publication. Differences in equipment components, specifications and performance resulting from The Singer Company's continuous product improvement program or individual customer design and application requirements are described in addendum sheets.

1-4. PURPOSE AND USE OF THE EQUIPMENT.

1-5. The Generator is a plug-in unit designed to develop a single- or two-tone audio signal of known frequency and amplitude when used in the PANORAMIC Model SSB-50 Single Sideband Analyzer System. Some typical applications of the Generator are listed below:

a. Single- or two-tone modulation of single sideband transmitters.

b. Intermodulation distortion measurements.

c. Harmonic distortion measurements.

d. Troubleshooting audio systems.

1-6. Inquiries are invited regarding special applications of the Generator to particular requirements. Such inquiries should be directed to the attention of the Applications Engineering Department.

1-7. GENERAL DESCRIPTION.

1-8. The Generator is a completely solid-state plug-in unit that is a source of continuously tunable single- or two-tone audio signals for testing of single sideband transmitters, exciters and audio systems. The frequency range of each test tone is adjustable from 20 Hz to 20 kHz in three decade ranges. The single- or two-tone output of the Generator is available at a front panel BNC jack for application to the system or device under test. Calibrated step attenuators permit adjustment of the output level from +10 to -60 dBm and a switchable internal 600-ohm termination enables the equipment to operate into 600-ohm or high impedance loads. The Generator occupies a half-rack width in the Model MF-50 Main Frame of the Model SSB-50 Single Sideband Analyzer System. Components are mounted on the rear of the front panel and on four printed circuit boards. Operating power for the Generator is provided by the main frame in which it is installed, thereby eliminating the need for an integral power supply.

1-9. SPECIFICATIONS.

1-10. Table 1-1 lists the electrical and physical characteristics of the Generator.

1-11. TRANSISTOR AND DIODE COMPLEMENT.

1-12. The transistor and diode complement of the Generator is given in table 1-2.

TABLE 1-1. SPECIFICATIONS

Frequency range (each tone):	Continuously tunable (in three decade ranges) from 20 Hz to 20 kHz
Frequency accuracy (each tone):	±3% of dial indication
Outputs:	Tone A, Tone B or Tones A and B algebraically summed

(Cont'd)

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TABLE 1-1. SPECIFICATIONS (Cont'd)

Output impedance:	600 ohms (unbalanced) to ground
Maximum power output (each tone):	+10 dBm
Attenuation range:	0 to 70 dB (+10 to -60 dBm), in 1-dB increments
Attenuator accuracy:	0.05 dB/dB, referenced to 0 dB
Flatness:	±0.5 dB from 20 Hz to 20 kHz
Intermodulation distortion:*	At least 66 dB below output signal level from 100 Hz to 10 kHz; at least 60dB below output signal level from 20 Hz to 20 kHz
Harmonic distortion: *	At least 66 dB below output signal level from 100 Hz to 10 kHz; at least 60 dB below output signal level from 20 Hz to 20 kHz
Hum and noise:	At least 66 dB below single-tone output signal level
Power requirements:	+15 volts (regulated) at 70 ma. -15 volts (regulated) at 70 ma.
Operating temperature range:	0 to +55°C (32 to 131°F)
Physical characteristics:	
Weight:	4-1/2 pounds
Width:	8-1/4 inches
Height:	5 inches
Depth (behind panel):	10-3/32 inches

* These distortion levels are maximum encountered over full temperature range. At normal ambient, distortions are typically less than -70dB.

TABLE 1-2. TRANSISTOR AND DIODE COMPLEMENT

Reference Designation	Type	Function
Transistors		
A1Q1 and A1Q2	2N3565	Emitter-coupled difference amplifier
A1Q3	2N3638A	Amplifier
A1Q4	2N3642	Emitter follower
A1Q5 and A1Q6	2N3638	Compound emitter follower
A2Q1 and A2Q2	2N3565	Emitter-coupled difference amplifier
A2Q3	2N3638A	Amplifier
A2Q4	2N3642	Emitter follower
A2Q5 and A2Q6	2N3638	Compound emitter follower

(Cont'd)

TABLE 1-2. TRANSISTOR AND DIODE COMPLEMENT (Cont'd)

Reference Designation	Type	Function
Transistors (cont'd)		
A3Q1 and A3Q2	2N3565	Emitter-coupled difference amplifier
A3Q3	2N3638A	Amplifier
A3Q4	2N3642	Emitter follower
A3Q5 and A3Q6	2N3642	Darlington emitter follower
A3Q7	2N3638	Part of complementary emitter follower
A3Q8	2N3642	Part of complementary emitter follower
Diodes		
A3CR1 through A3CR3	1N251	Temperature compensation and crossover distortion elimination diodes

SECTION II
OPERATION

2-1. GENERAL.

2-2. This section contains installation and operating instructions for the Generator. The Generator has been factory tested and aligned and is shipped in a ready-to-operate condition. However, no attempt should be made to install or operate the unit until the operator is thoroughly familiar with the contents of this section. Figure 2-1 is an outline dimension drawing of the Generator.

2-3. INSTALLATION.

2-4. To install a Generator in the Model MF-50 Main Frame, insert the Generator in the cavity and firmly seat it in place. If any resistance is noted while inserting the Generator, withdraw it and examine the connector on the rear of the Generator and the rear wall of the main frame cavity for proper alignment. Tighten the front panel fastener on the Generator to mechanically secure it to the main frame.

2-5. OPERATION.

2-6. OPERATING CONTROLS AND CONNECTORS. The operating controls and connectors for the Generator are described in table 2-1 and shown in figure 2-2.

2-7. Paragraphs 2-8 through 2-10 describe how to operate the Generator. These procedures assume that power is applied to the unit.

2-8. PRELIMINARY ADJUSTMENTS. Perform the following preliminary adjustments prior to using the Generator.

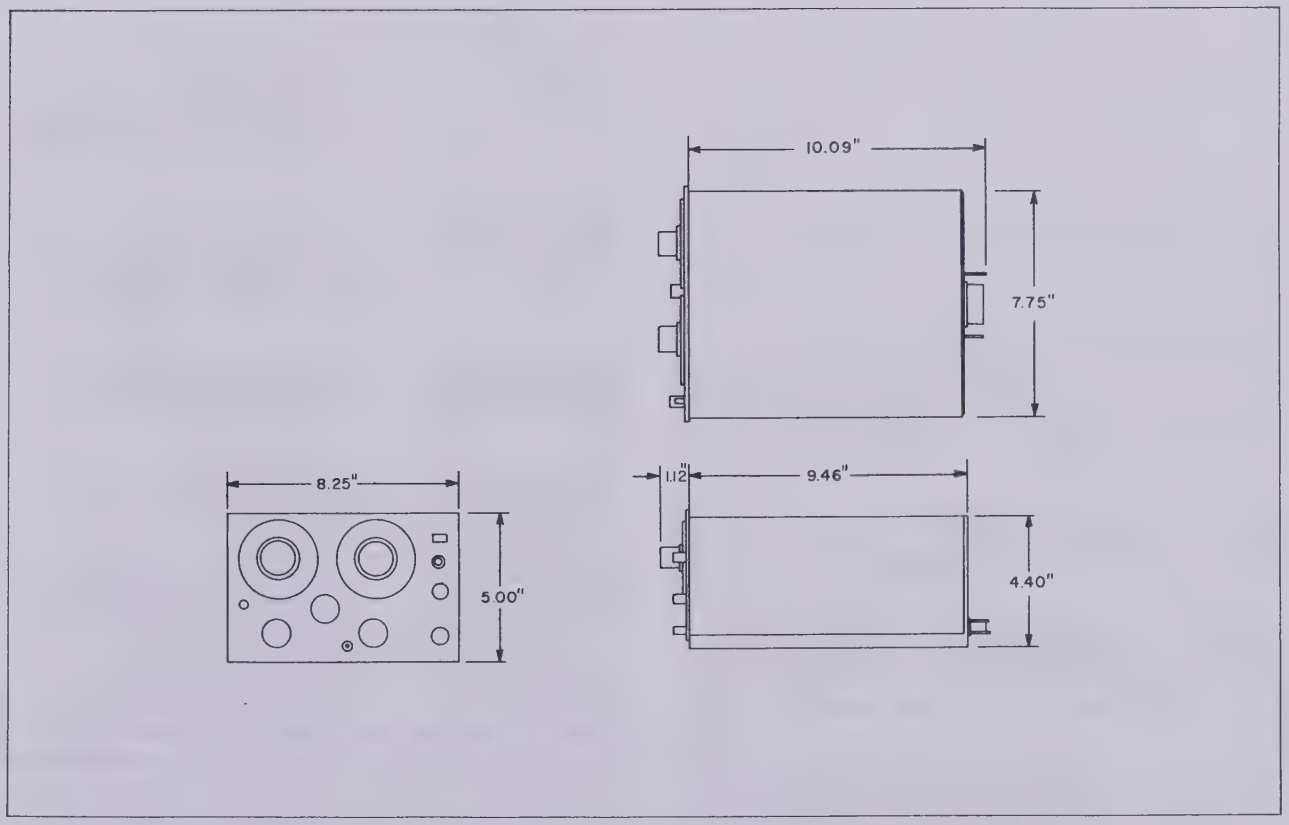


Figure 2-1. Outline Dimension Drawing, Generator

TABLE 2-1. OPERATING CONTROLS AND CONNECTORS

Index No. (Figure 2-2)	Reference Designation	Name	Function
1	S1	FREQ A range multiplier switch	Decade range multiplier for frequency tone A.
2	A4R28	FREQ A screwdriver control	Adjusts output level of tone A at +10 dBm into 600 ohms.
3	R1	FREQ A control and dial	Tunes tone A oscillator (in conjunction with FREQ A range multiplier switch) to any frequency between 20 Hz and 20 kHz.
4	S3	OUTPUT selector switch	Permits operation as either a single-tone or two-tone generator.
5	S2	FREQ B range multiplier switch	Decade range multiplier for frequency tone B.
6	R2	FREQ B control and dial	Tunes tone B oscillator (in conjunction with FREQ B range multiplier switch) to any frequency between 20 Hz and 20 kHz.
7	S5	600 Ω TERMINATION switch	Inserts internal 600-ohm termination (when set to IN) to maintain output level calibration accuracy when operating into high impedance loads.
8	J1	OUTPUT +10 DBM MAX jack	Connector at which the single- or two-tone output of the generator is available for application to external load.
9	A4R29	LEVEL B screwdriver control	Adjusts output level of tone B at +10 dBm into 600 ohms.
10	S4	ATTENUATOR DB decade switch	Attenuates output signal up to 60 dB in 10-dB steps.
11	A4S1	ATTENUATOR DB ADD units switch	Attenuates output signal up to 10 dB in 1-dB steps.
12	-	Fastener	Secures Generator to main frame.

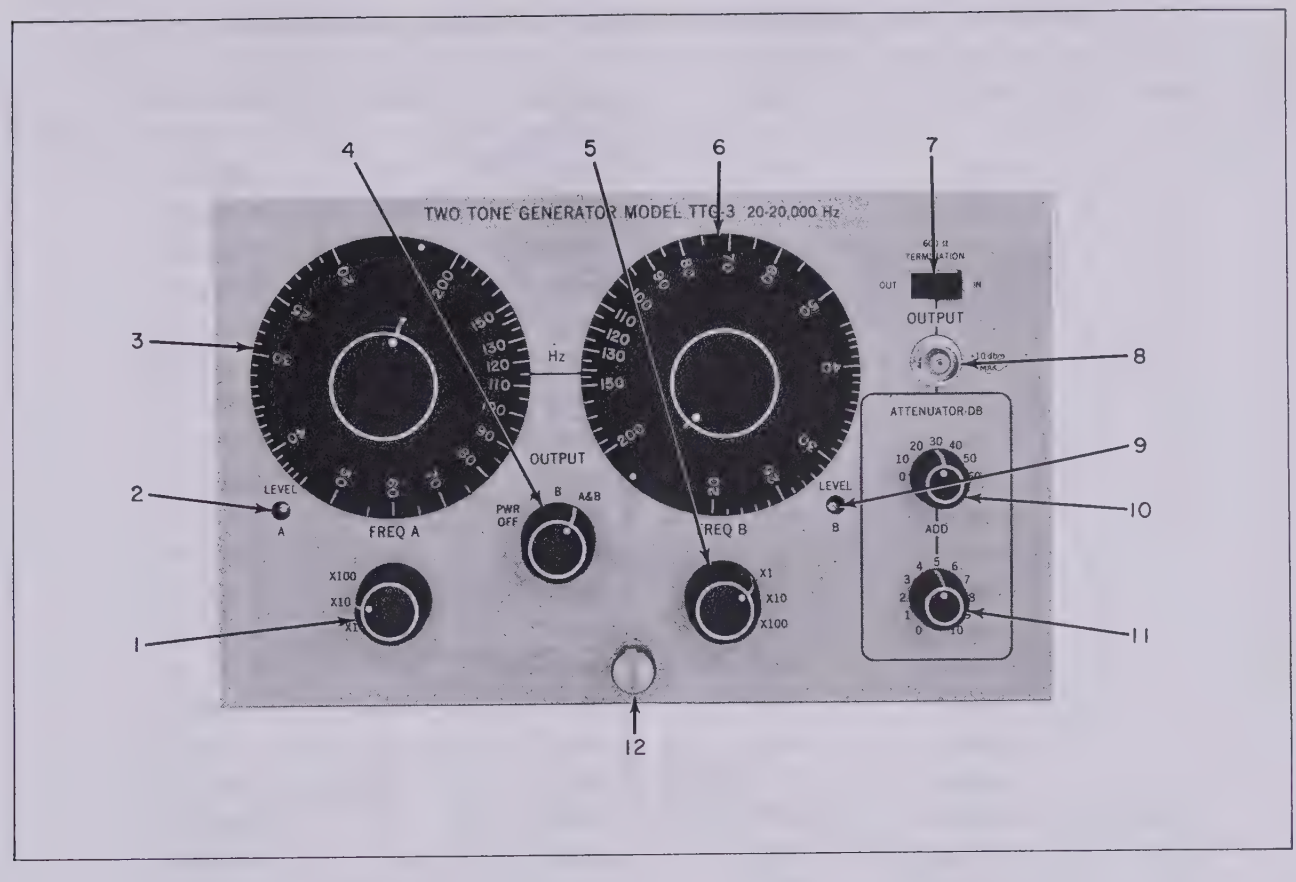


Figure 2-2. Generator Operating Controls and Connectors

a. Set the ATTENUATOR DB decade and ATTENUATOR DB ADD units switches to 0 and set the 600Ω TERMINATION switch to IN.

b. Connect a vtvm to the OUTPUT +10 DBM MAX jack and set the OUTPUT selector switch to A.

c. Adjust the FREQ A control to obtain a dial indication of 100 and set the FREQ A range multiplier switch to X10.

d. Carefully adjust the LEVEL A screwdriver control to obtain a vtvm indication of +10 dBm (2.45 volts into 600 ohms).

e. Set the OUTPUT selector switch to B.

f. Adjust the FREQ B control to obtain a dial indication of 100 and set the FREQ B range multiplier switch to X10.

g. Carefully adjust the LEVEL B screwdriver control to obtain a vtvm indication of +10 dBm (2.45 volts into 600 ohms).

h. Disconnect the vtvm. The Generator is ready for operation.

2-9. SINGLE-TONE OUTPUT. Proceed as directed below to obtain a single-tone output.

a. Perform the preliminary adjustments detailed in paragraph 2-8.

b. Set the OUTPUT selector switch to A.

c. Set FREQ A dial and the corresponding range multiplier switch to obtain the desired signal frequency.

d. Set the 600Ω TERMINATION switch to that position corresponding to the load. (If the output of the Generator is to be coupled to a 600-ohm load, set the 600Ω TERMINATION switch to OUT. Conversely, if the output is to be coupled to a high-impedance load, set the 600Ω TERMINATION switch to IN.)

e. Set the ATTENUATOR DB decade and ATTENUATOR DB ADD units switches to obtain the desired output level (see table 2-2).

f. Couple the OUTPUT +10 DB MAX jack to the device under test. Note that the Generator may be shut off, without de-energizing the remainder of the system, by setting the OUTPUT selector switch to OFF.

2-10. TWO-TONE OUTPUT. Proceed as directed below to obtain a two-tone output from the Generator.

TABLE 2-2. DBM (INTO 600 OHMS) TO RMS VOLTS CONVERSION CHART

dBm	Rms Volts	dBm	Rms Volts	dBm	Rms Volts
+10	2.45	-14	1.55×10^{-1}	-38	9.75×10^{-2}
+9	2.18	-15	1.36×10^{-1}	-39	8.68×10^{-3}
+8	1.95	-16	1.23×10^{-1}	-40	7.74×10^{-3}
+7	1.74	-17	1.09×10^{-1}	-41	6.90×10^{-3}
+6	1.55	-18	9.75×10^{-2}	-42	6.15×10^{-3}
+5	1.36	-19	8.68×10^{-2}	-43	5.49×10^{-3}
+4	1.23	-20	7.74×10^{-2}	-44	4.88×10^{-3}
+3	1.09	-21	6.90×10^{-2}	-45	4.35×10^{-3}
+2	9.75×10^{-1}	-22	6.15×10^{-2}	-46	3.86×10^{-3}
+1	8.68×10^{-1}	-23	5.49×10^{-2}	-47	3.46×10^{-3}
0	7.74×10^{-1}	-24	4.88×10^{-2}	-48	3.08×10^{-3}
-1	6.90×10^{-1}	-25	4.35×10^{-2}	-49	2.74×10^{-3}
-2	6.15×10^{-1}	-26	3.86×10^{-2}	-50	2.45×10^{-3}
-3	5.49x10-1	-27	3.46×10^{-2}	-51	2.18×10^{-3}
-4	4.88×10^{-1}	-28	3.08×10^{-2}	-52	1.95×10^{-3}
-5	4.35×10^{-1}	-29	2.74×10^{-2}	-53	1.74×10^{-3}
-6	3.86×10^{-1}	-30	2.45×10^{-2}	-54	1.55×10^{-3}
-7	3.46×10^{-1}	-31	2.18×10^{-2}	-55	1.36×10^{-3}
-8	3.08×10^{-1}	-32	1.95×10^{-2}	-56	1.23×10^{-3}
-9	2.74×10^{-1}	-33	1.74×10^{-2}	-57	1.09×10^{-3}
-10	2.45×10^{-1}	-34	1.55×10^{-2}	-58	9.75×10^{-3}
-11	2.18×10^{-1}	-35	1.36×10^{-2}	-59	8.68×10^{-4}
-12	1.95×10^{-1}	-36	1.23×10^{-2}	-60	7.74×10^{-4}
-13	1.74×10^{-1}	-37	1.09×10^{-2}		

a. Perform the preliminary adjustments detailed in paragraph 2-8.

b. Set the OUTPUT selector switch to A & B.

c. Set the FREQ A control and FREQ A range multiplier switch to obtain one of the desired tones.

d. Set the FREQ B control and FREQ B range multiplier switch to obtain the second desired tone.

e. Set the 600Ω TERMINATION switch to that position corresponding to the load. (If the output of the Generator is to be coupled to a 600-ohm load, set the 600Ω TERMINATION switch to OUT. Conversely, if the output is to be coupled to a high impedance load, set the 600Ω TERMINATION switch to IN.)

f. Set the ATTENUATOR DB decade and ATTENUATOR DB ADD units switches to obtain the desired output level (see table 2-2). Note that, to obtain an output level of -27 dBm, subtract -27 dBm from +10 dBm; this yields a difference of 37 dB. Therefore, set the ATTENUATOR DB decade switch to 30 and the ATTENUATOR DB units switch to 7.

g. Couple the OUTPUT +10 DBM MAX jack to the device under test. Note that the Generator may be shut off, without de-energizing the remainder of the system, by setting the OUTPUT selector switch to PWR OFF.

2-11. PACKAGING INSTRUCTIONS.

2-12. The following packaging instructions provide information for short-term and long-term storage and shipping of the Generator.

2-13. SHORT-TERM PACKAGING. For short-term packaging, the Generator should be enclosed in a polyethylene bag and placed in a suitable carton for protection. The carton should be stored in a clean and moisture-free area. All accessories and literature should be securely fastened to the equipment.

2-14. LONG-TERM PACKAGING AND PACKAGING FOR SHIPMENT. Figure 2-3 illustrates the packaging procedure for the Generator.

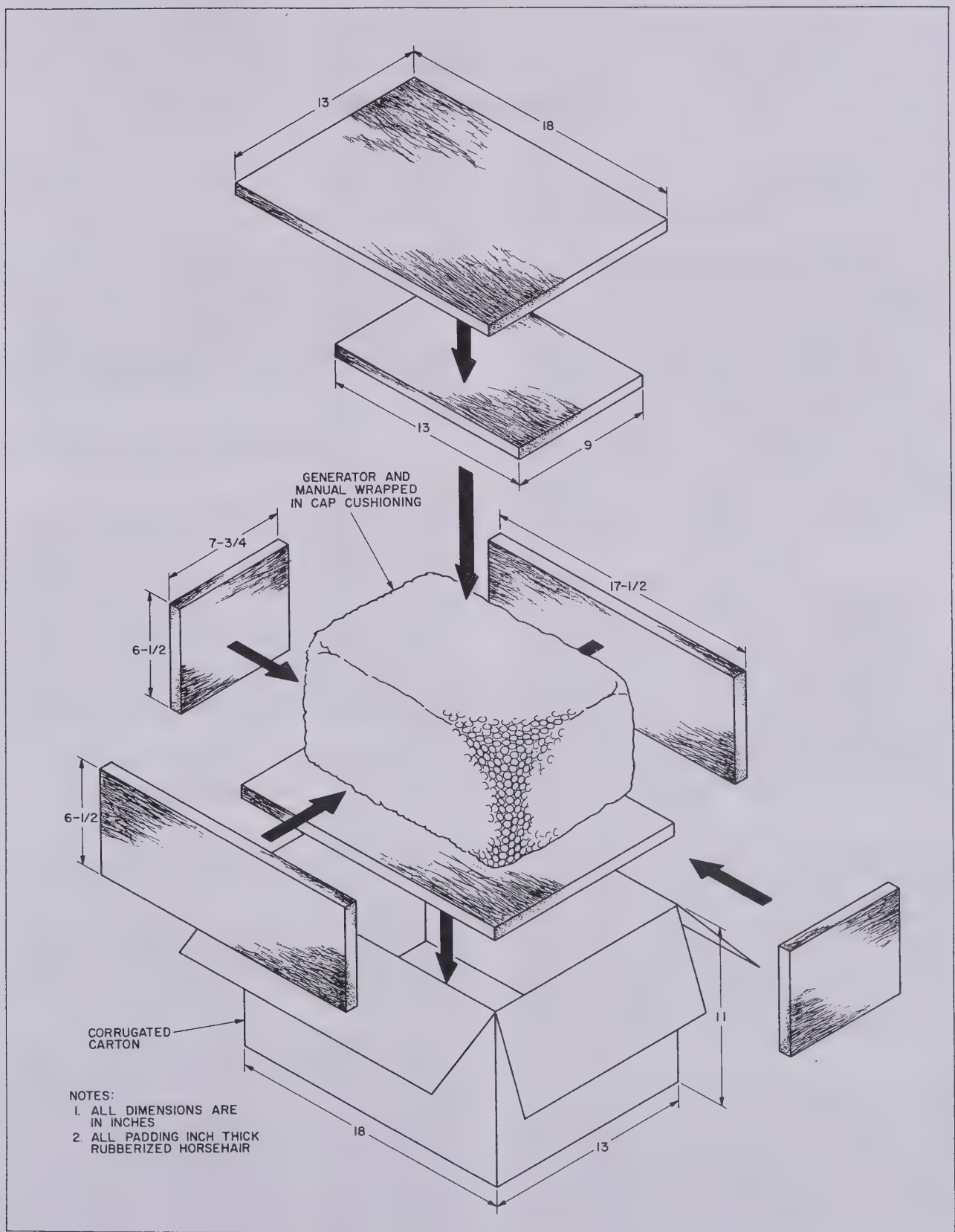


Figure 2-3. Packaging the Generator

SECTION III
THEORY OF OPERATION

3-1. GENERAL.

3-2. This section contains the theory of operation for the Generator. The Generator is a completely solid-state plug-in device that generates either a single-tone or two-tone audio signal, the frequency of each tone being continuously and independently tunable over the frequency range from 20 Hz to 20 kHz. Operating power for the Generator is provided by its associated main frame.

3-3. BLOCK DIAGRAM ANALYSIS.

3-4. The Generator (figure 3-1) consists of two bridged-T oscillators which each develop an audio tone continuously tunable over the frequency range from 20 Hz to 20 kHz. The output of either one or both of the oscillators, determined by the setting of the OUTPUT selector switch, is applied to a summing amplifier. The resulting single-tone or two-tone output of the summing amplifier is coupled to the OUTPUT +10 DBM MAX jack through an attenuator that provides up to 70 dB of signal attenuation. An internal 600-ohm termination is provided to permit the Generator to operate into high impedance loads.

3-5. DETAILED THEORY OF OPERATION. (See Figures 3-1 and 5-1.)

3-6. The Generator consists of four major sections: two oscillators; summing amplifier; and output attenuator. Each of these is discussed below.

3-7. OSCILLATORS. Each oscillator consists of a four-stage amplifier chain containing two feedback loops. Since both the tone A and tone B oscillators are electronically identical, the ensuing discussion will only cover the operation of the tone A oscillator.

3-8. Transistors A1Q1 and A1Q2 form a highly-stable emitter-coupled difference amplifier. The output of a positive feedback loop (refer to paragraph 3-10) is fed back to the base of A1Q1, while that of a negative feedback loop (refer to paragraph 3-9) is applied to the base of A1Q2. The output of the difference amplifier, taken at the collector of A1Q2, is proportional to the difference between the two feedback voltages. This difference voltage is coupled through amplifier A1Q3 and emitter A1Q4 and applied to a compound emitter follower consisting of A1Q5 and A1Q6. This stage is effectively a very low output impedance emitter follower in which A1Q6 functions as a variable emitter resistance.

3-9. The positive feedback network consists of resistors A1R6 through A1R8 and thermistor A4RT1. Any circuit disturbance (such as component aging or variations in supply voltage) which causes the oscillator output level to increase will simultaneously increase the voltage across the thermistor. This, in turn, will cause the thermistor to dissipate more power with a corresponding increase in temperature. Since thermistors have a negative temperature coefficient of resistance, this rise in power dissipation (temperature) will result in a reduction of the feedback voltage. This action tends to return the oscillator output level to the proper value (refer to paragraph 3-12). Conversely, should the oscillator output level tend to fall off, the feedback voltage will increase to return the level to its proper value.

3-10. The negative feedback path consists of a frequency-selective bridged-T rejection filter. For the purposes of this discussion, it is expedient to redraw the bridged-T network as illustrated in figure 3-2. The full input voltage to the bridged-T rejection filter network (E_{IN}) is applied across R1-C2. (Since the output of the network is applied to the high impedance input of A1Q1, the effects of loading will be neglected.) The output voltage (E_{OUT}) of the bridged-T rejection filter network is the sum of the voltages across R2 and C2. It is readily seen that the sum of the voltages across C1 and R2 is equal to the voltage across R1.

3-11. When the voltage vector E_{IN} is resolved to yield E_{R1} and E_{C2} and when E_{R1} is resolved to yield E_{R2} and E_{C1} (see figure 3-2b), it may be shown that, for proper component values, the vector sum of E_{R2} and E_{C2} ($= E_{OUT}$) will be a minimum for only one frequency (f_o). A composite plot of the transfer function and phase characteristics of the bridged-T network as a function of frequency is illustrated in figure 3-2c. For the given component values there will be the frequency f_o where transmission through the network will be a minimum and the total phase shift will be 0°.

3-12. At frequency f_o, the null in the negative feedback path results in an overall closed-loop gain of slightly greater than unity, thereby enabling the circuit to sustain oscillations at the selected frequency. Vernier control of the oscillator is achieved by varying the resistance in the arms of the bridged-T network, while decade ranging is accomplished by switching the capacitive elements.

3-13. SUMMING AMPLIFIER. The output of the selected oscillator is coupled through OUTPUT selector switch S3 and applied to a resistive summing network consisting of A3R1, A3R2 and feedback resistor A3R19. LEVEL A screwdriver control A4R28 and LEVEL B screwdriver control A3R29 are in series with the selected signal and serve to adjust the output level of each oscillator to obtain a calibrated output level of +10 dBm when the oscillator is tuned to 1 kHz. The summed signal voltage is applied to the base of an emitter-coupled difference amplifier (A3Q1 and A3Q2) and the output of the amplifier, taken at the collector of A3Q2, is coupled through amplifier A3Q3 and emitter follower A3Q4 to the output stage.

3-14. The output stage consists of a Darlington-type emitter follower (A3Q5 and A3Q6) and a complementary-pair emitter follower (A3Q7 and A3Q8) which function essentially as a totem pole amplifier. Diodes A3CR1 through A3CR3 develop a small forward bias voltage for the bases of A3Q5 and A3Q7 to eliminate unwanted cross-over distortion. Low distortion, an extremely flat frequency response and a low output impedance is achieved through the use of negative feedback. The overall gain of the summing amplifier is adjustable over a range of 10 dB (in 1-dB increments independent of the setting of the decade step attenuator) by means of ATTENUATOR DB ADD switch A4S1 and associated circuitry, which adjusts the shunting resistance across feedback resistor A3R19.

3-15. OUTPUT ATTENUATOR. The output of the summing amplifier is coupled to OUTPUT +10 DBM MAX jack J1 through a 60-dB step attenuator. When ATTENUATOR DB switch S4 is set to any position other than 0, the output impedance of the Generator, seen looking back into the attenuator, is 600 ohms. When the ATTENUATOR DB switch is set to 0, the Generator has a very low output impedance and approximates an ideal voltage source.

3-16. Operation of the Generator into a high impedance load requires that a 600-ohm terminating resistor be inserted to maintain the calibration accuracy of the equipment. This termination is provided by 600 Ω TERMINATION switch S5 which, when set to IN, ties R5 to the output of the decade step attenuator.

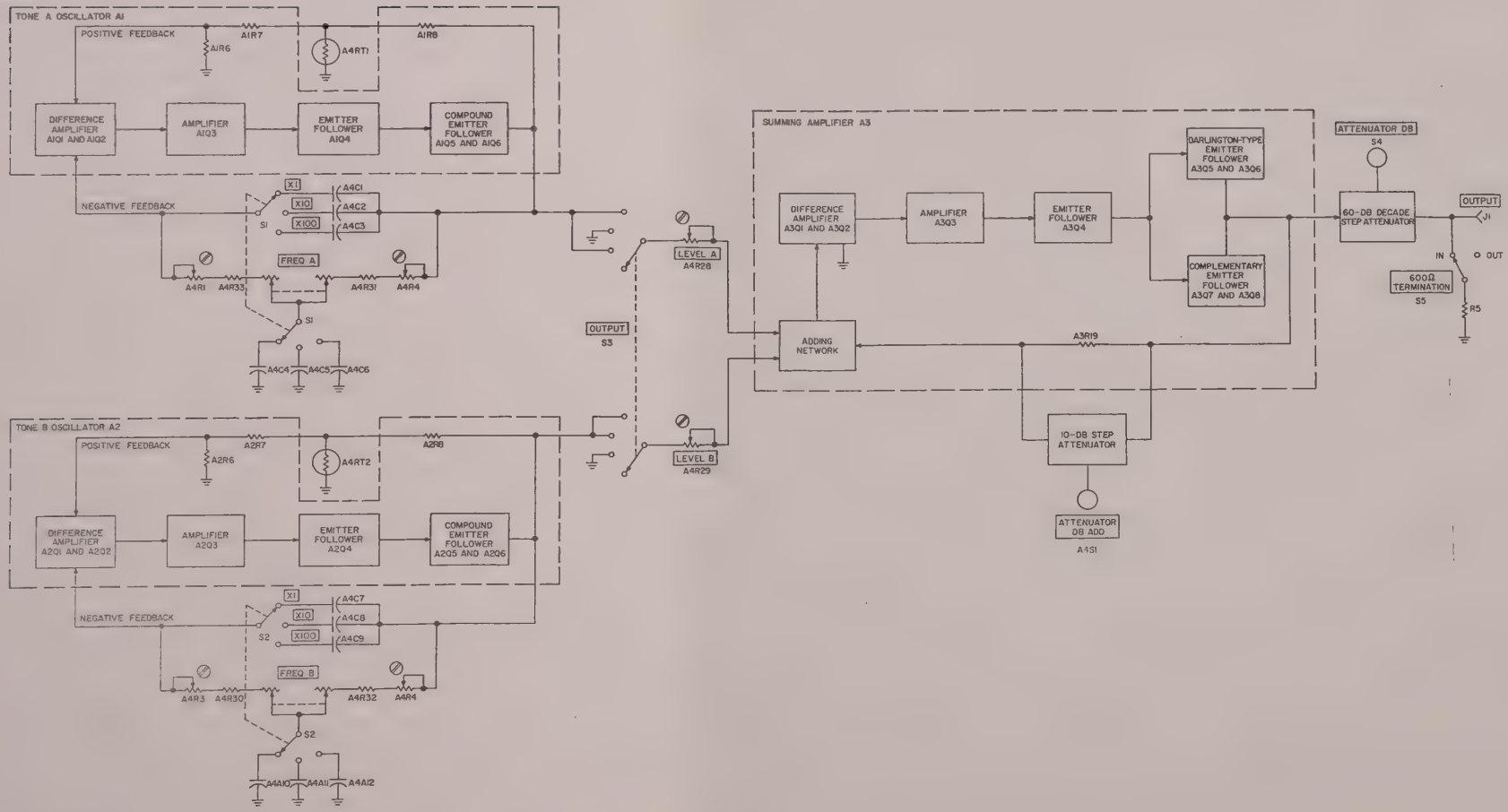
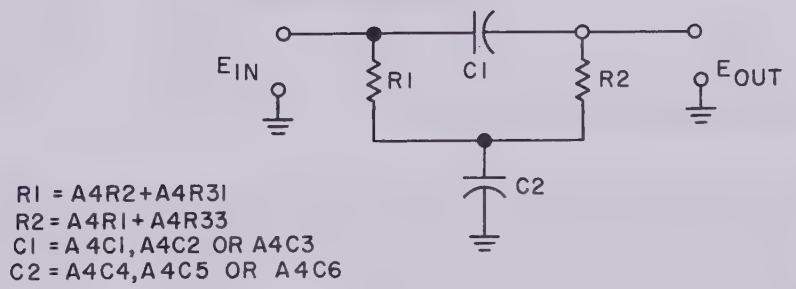
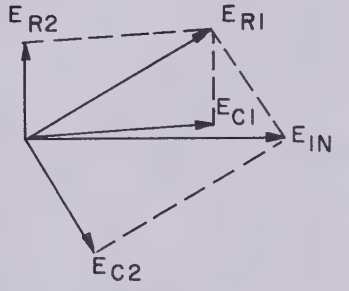


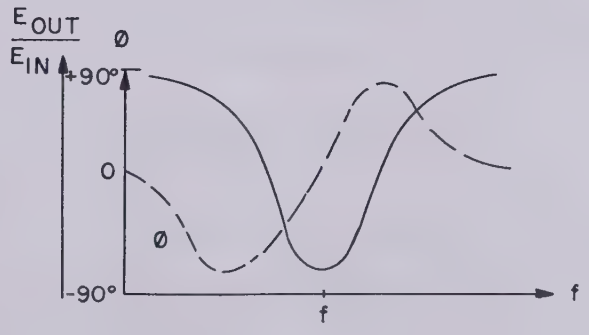
Figure 3-1. Generator, Block Diagram



a. Redrawn Bridged-T Network



b. Vector Diagram



c. Transfer and Phase Characteristics

Figure 3-2. Bridged-T Circuit Analysis.

SECTION IV
MAINTENANCE

4-1. GENERAL.

4-2. This section contains maintenance instructions for the Generator. No attempt should be made to repair internal components or make adjustments until the operator is thoroughly familiar with the information contained in this section.

4-3. The performance of the Generator may be checked using the minimum performance standards checks provided to determine whether the equipment is operating within published specifications. A systematic troubleshooting procedure to isolate the trouble in the Generator and an alignment procedure to restore the equipment to proper operating condition after the required repairs have been effected are also included in this section.

4-4. TEST EQUIPMENT REQUIRED.

4-5. The test equipment required for the maintenance and alignment of the Generator is listed in table 4-1. Equipment having similar characteristics may be substituted for those listed in the table.

4-6. PRELIMINARY INSPECTION.

4-7. Preliminary inspection of the equipment is performed with the Generator removed from the main frame and without operating power applied. This type of check is designed to detect conditions that might otherwise lead to a breakdown. Frequent causes of equipment failure are overheating of components due to improper ventilation, accumulation of dust and dirt and/or loose connections and fittings. Inspection is carried out with emphasis on finding evidence of these conditions.

4-8. COMPONENT LOCATIONS. The location of components mentioned in the inspection routines, alignment and troubleshooting procedures are illustrated in figure 4-1.

4-9. PRELIMINARY INSPECTION ROUTINE. Table 4-2 lists the preliminary inspection routine for the Two-Tone Generator.

4-10. MINIMUM PERFORMANCE STANDARDS.

4-11. The minimum performance standards checks listed in table 4-3 provide a rapid, convenient means of ascertaining proper Generator operation. These

TABLE 4-1. TEST EQUIPMENT REQUIRED

Type of Equipment	Suggested Manufacturer Name and Model No.	Use
Frequency Counter	General Radio Model 1153-A	Frequency calibration
Oscilloscope	Tektronix Model 503	General waveform analysis
Vtvm	RCA Model WV-98C	Voltage measurements
Wave Analyzer	Hewlett-Packard Model 302A	Measuring harmonic and intermodulation components
Signal Generator	General Radio Model 1210-C	Troubleshooting
AC Vtvm	Ballantine Model 303	Measuring flatness and accuracy of output attenuator

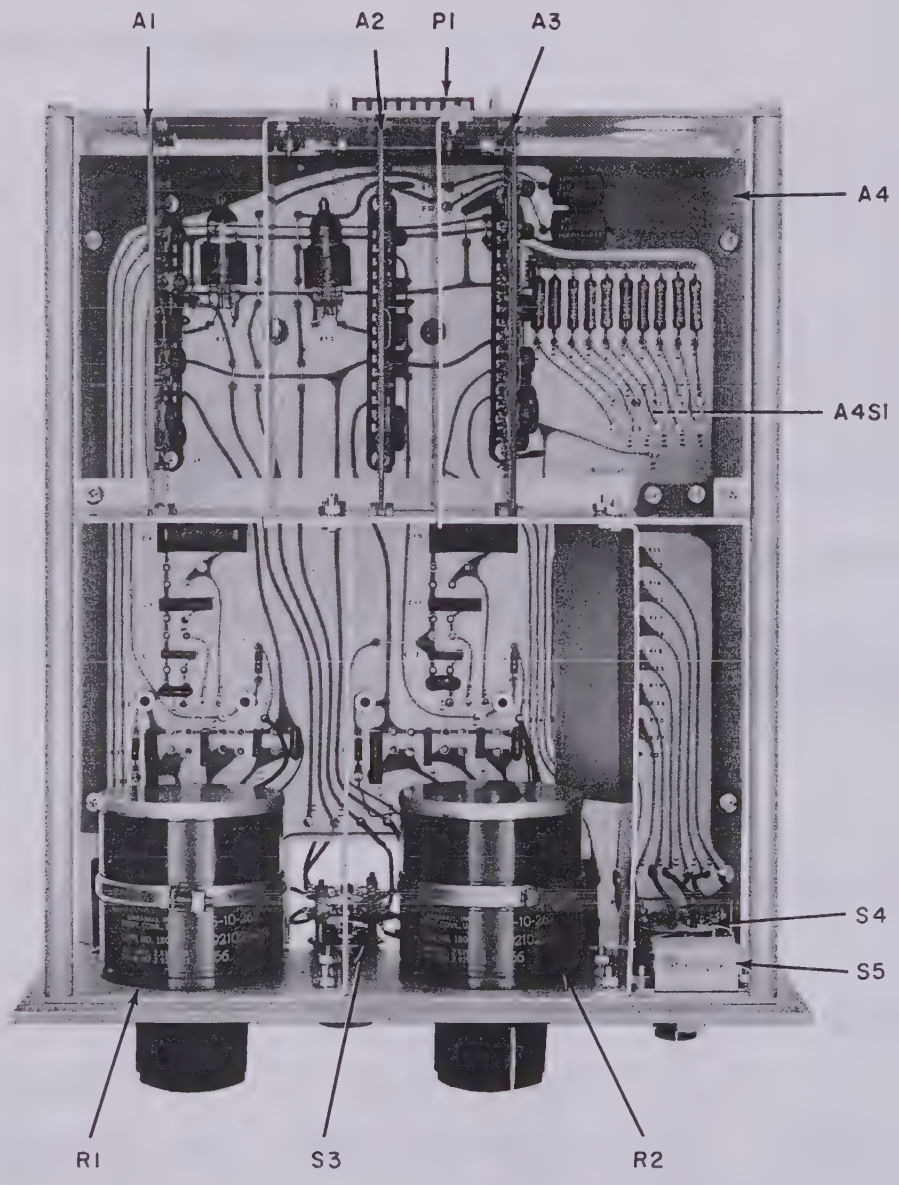


Figure 4-1. Generator, Top View

TABLE 4-2. PRELIMINARY INSPECTION ROUTINE

Item	Inspect For	Corrective Action
Plug P1 at rear of Generator	Looseness, bent or corroded contacts, signs of arcing	Clean contacts with cloth moistened with cleaning solvent (trichloroethylene or equivalent). Replace plug if damaged.
		Replace jack if damaged or corroded.
Generator case and panels	Dirt and Corrosion	Clean with cloth moistened with cleaning solvent (trichloroethylene or equivalent).
Knobs, screws, connectors, clamps	Looseness	Tighten using appropriate torque so as not to strip threads.
Switches	Looseness	Tighten mounting screws or nut.
Wiring	Looseness	Resolder, recable, or reclamp.
	Frayed, worn, or missing insulation	Rewire as required.
Solder joints	Loose or cold solder connections; corrosion	Clean carefully and resolder.
Printed circuit boards	Mounting looseness	Replace mating plug if required.
	Loose components	Resolder loose components.
Resistors	Cracks, chipping, blistering, discoloration, and other signs of overheating	Replace resistor and ensure that overheating is not due to other defective components.
Capacitors	Leaks, bulges, signs of aging	Replace capacitor.
	Loose mounting bracket	Tighten nuts or screws holding bracket.
Switch contacts	Dirt, dust, and/or corrosion	Clean with cloth, aerosol spray, syringe or camel-hair brush using trichloroethylene or equivalent.
	Bent or broken contacts	Replace switch wafer or assembly.
Transistors	Looseness	Tighten clips.

checks are performed with the Generator operating in the Model SSB-50 Single Sideband Analyzer System (or equivalent). The quality of these checks presupposes that the MF-50 is operating within acceptable limits, thus, procedures in the technical manual for the MF-50 should be performed prior to performing the checks. Before performing these checks, position the controls of the SSB-50 system as indicated below:

a. On the MF-5:
SCALE ILLUMINATION-OFF control OFF

b. On the MF-50:
Power switch OFF

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS

Step	Purpose	Procedure	Acceptable Indication
1	To check frequency accuracy of tone A and B oscillators.	a. Connect the frequency counter to the OUTPUT +10-DBM MAX jack and set the OUTPUT selector switch to A. Observe indication on frequency counter. b. Repeat step 1a for all numerical markings on FREQ A control (25, 30, 35, etc.). c. Set the FREQ A range multiplier switch to X10 and repeat steps 1a and 1b. d. Set the FREQ A range multiplier switch to X100 and repeat steps 1a and 1b. e. Set the OUTPUT selector switch to B and repeat steps 1a through 1d, using corresponding controls of tone B oscillator.	Frequency counter reads within ±3% of selected frequency.
2	To check flatness of tone A and B oscillators.	a. Set the OUTPUT selector switch to A, the FREQ A control to 100 and the FREQ A range multiplier switch to X10. Disconnect the frequency counter and connect the AC vtvm to the OUTPUT +10DBM MAX jack. Adjust the LEVEL A screwdriver control to obtain a 2.45 volts rms indication (or +10 dBm) on the AC vtvm. b. While observing the indication on the AC vtvm, slowly adjust the FREQ A control through its entire range. c. Set the FREQ A range multiplier switch to X1 and repeat step 2b. d. Set the FREQ A range multiplier switch to X100 and repeat step 2b. e. Set the OUTPUT selector switch to B, the FREQ B control to 100, and the FREQ B range multiplier switch to X10. Repeat steps 2a through 2d, using corresponding controls of the B oscillator.	AC vtvm indicates 2.45 volts rms at 1000Hz and variation thereafter does not vary more that ±0.5dB as FREQ A or FREQ B control is adjusted through its entire range. **Note** Disregard transient amplitude fluctuations as the FREQ A or FREQ B control is adjusted.

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
3	To check accuracy of output attenuator.	a. Set the OUTPUT selector switch to B, and FREQ B control to 100, and the FREQ B range multiplier switch to X10. Observe that with the ATTENUATOR DB decade and ATTENUATOR DB ADD switches set to 0, the AC vtvm (connected as in step 2) indicates 2.45 volts rms. While observing the AC vtvm, vary the ATTENUATOR DB ADD switch in 1-dB steps from 0 to 10.	a. Ac vtvm indication decreases in 1-dB steps (approximately) as the ATTENUATOR DB ADD switch is increased in 1-dB steps from 0dB.
		b. Return the ATTENUATOR DB ADD switch to 0 dB. While observing the indication on the AC vtvm, vary the ATTENUATOR DB switch in 10-dB steps from 0 to 60.	b. Ac vtvm indication decreases in 10-dB steps (±.05dB/dB) as the ATTENUATOR DB switch is increased in 10-dB steps from 0dB.
4	To check harmonic distortion.	a. Disconnect the AC vtvm and connect a wave analyzer to the ± 10DBM MAX jack. Set the FREQ A control to 100, the FREQ A range multiplier to X10, the OUTPUT selector switch to A, and the ATTENUATOR DB decade and ATTENUATOR DB ADD units switches to 0. Tune the wave analyzer to the selected frequency and record the wave analyzer indication. Then tune the wave analyzer to the second and third harmonics of the selected frequency and note the wave analyzer indication.	a. Harmonic distortion is at least 66dB below the selected frequency.
		b. Repeat step 4a for tone A frequencies of 2kHz, 5kHz, and 10kHz.	b. Same as step 4a.
		c. Repeat step 4a for a tone A frequency of 20kHz.	c. Harmonic distortion is at least 60dB below the selected frequency.
		d. Repeat steps 4a through 4c for the tone B oscillator.	d. Same as steps 4a through 4c.
5	To check intermodulation distortion.	a. With the wave analyzer still connected to the +10DBM MAX jack, set the tone A oscillator frequency to 5kHz and the tone B oscillator frequency to 7kHz. Set the ATTENUATOR DB decade and ATTENUATOR DB ADD units switches to 0 and the OUTPUT selector switch to	a. All intermodulation distortion products are at least 66dB down.

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
5 (Cont'd)		AB. Adjust the wave analyzer for a reference level and then measure the amplitudes of the following distortion products: 2kHz; 3kHz; 9kHz; and 12kHz. b. Repeat step 5a with tone A and B frequencies of 18kHz and 20kHz, respectively, and measure the amplitudes of the following distortion products: 2kHz; 16kHz; 22kHz, and 38kHz.	b. All intermodulation distortion products are at least 60dB down.

c. On the Generator:

OUTPUT selector switch	PWR OFF
600Ω TERMINATION switch	IN
FREQ A control	20
FREQ A range multiplier switch	X1
FREQ B control	20
FREQ B range multiplier switch	X1
ATTENUATOR DB decade switch	0
ATTENUTATOR DB ADD units switch	0

4-12. POWER SUPPLY CHECK.

4-13. Before proceeding with systematic troubleshooting of the Generator, the +15 vdc and -15 vdc input voltages from the main frame should be checked. This check will usually determine whether abnormal d-c voltages are causing the malfunction. To check these voltages, remove the Generator from the main frame and connect d-c power to it using the service cable provided with the SSB-50 system. Remove the top cover and use the RCA Model WV-98C VTVM to measure the +15 vdc supply voltage between pin P1-2 (positive) and P1-9 (negative); and the -15 vdc supply voltage between pin P1-11 (negative) and P1-9 (positive).

4-14. SYSTEMATIC TROUBLE LOCALIZATION.

4-15. Three possible troubles are presented in table 4-4 to illustrate a systematic approach to the isolation of trouble within the Generator. This procedure is performed with the Generator operating in an SSB-50 system and connected to the Model MF-50 Main Frame via the supplied service cable. Note that full use is made of the maintenance information in the manual (e.g., the block diagram, the voltage charts and the schematic diagram).

4-16. The three possible problems that will be considered are:

a. No tone A signal is obtainable but a tone B signal can be obtained.

b. No tone B signal is obtainable but a tone A signal can be obtained.

c. Neither tone A nor tone B signal is obtainable.

Before referring to table 4-4 for problems a or b above (only one of the tones is obtainable), interchange boards A1 and A2 to quickly determine whether the malfunction is on board A1 (or A2). If it is, troubleshoot the particular board using the corresponding procedure (symptom 1 of 2) in table 4-4. If it isn't, check the components and connections on mother board A4 which relate to the missing tone. Also check the front panel controls and switches affecting the defective circuit.

4-17. FREQUENCY CALIBRATION.

4-18. To calibrate the frequency of either oscillator, proceed as directed in the following steps.

Note

The information contained within parenthesis applies to the tone B oscillator, and immediately follows the corresponding data applicable to the tone A oscillator.

a. With the ATTENUATOR DB decade and ATTENUATOR DB ADD units switches set to 0 and the 600Ω TERMINATION switch set to IN, connect a frequency counter to the OUTPUT +10DBM MAX jack. Set the OUTPUT selector switch to A (B).

b. Set the FREQ A (FREQ B) range multiplier switch to X10 and rotate the FREQ A (FREQ B) control fully clockwise. At the fully clockwise position of the FREQ A (FREQ B) control, the dot on the FREQ A (FREQ B) dial should line up with the fiducial marker on the front panel. If not, loosen the setscrew that secures the FREQ A (FREQ B) knob to its control shaft and remove the knob.

TABLE 4-4. SYSTEMATIC TROUBLE LOCALIZATION

No.	Symptom	Test Procedure	If Indication Is Normal	If Indication Is Abnormal
1	No tone A signal is obtainable but a tone B signal can be obtained.	a. Set the OUTPUT selector switch to PWR OFF and withdraw tone A oscillator board A1. Insert the extender board (supplied with the SSB-50 system) into the vacated connector and mount A1 atop the extender board. Ground the base of A1Q2 and connect an audio generator (tuned to 1 kHz) to the base of A1Q1 through a 1-uf capacitor. Connect an oscilloscope to the base of A1Q1. Adjust the FREQ A control and FREQ A range multiplier switch for a Generator frequency of 1 kHz. Set the OUTPUT selector switch to A and adjust the signal generator output level to obtain a 10-millivolt peak-to-peak signal, as displayed on the oscilloscope.		
		b. Connect the oscilloscope to the collector of A1Q1 and note the display; it should be a sinusoidal waveform having a peak-to-peak amplitude of approximately 75 millivolts.	b. Go to step c.	b. Check A1Q1 and associated circuitry.
		c. Connect the oscilloscope to the collector of A1Q2 and note the oscilloscope display; it should be a sinusoidal waveform having a peak-to-peak amplitude of approximately 70 millivolts.	c. Go to step d.	c. Check A1Q2 and associated circuitry.
		d. Connect the oscilloscope to the collector of A1Q3 and note the display; it should be a sinusoidal waveform having a peak-to-peak amplitude of approximately 13 volts.	d. Go to step e.	d. Check A1Q3 and associated circuitry.
		e. Connect the oscilloscope to the emitter of A1Q6 and note the display; it should be a sinusoidal waveform having a peak-to-peak amplitude of approximately 13 volts.	e. Check S1 and associated circuitry.	e. Check A1Q4, A1Q5, A1Q6 and associated circuitry.

(Cont'd)

TABLE 4-4. SYSTEMATIC TROUBLE LOCALIZATION (Cont'd)

No.	Symptom	Test Procedure	If Indication Is Normal	If Indication Is Abnormal
2	No tone B signal is obtainable but a tone A signal can be obtained.	a. Set the OUTPUT selector switch to PWR OFF and withdraw tone B oscillator board A2. Insert the extender board into the vacated connector and mount A2 atop the extender board. Ground the base of A2Q2 and connect an audio oscillator (tuned to 1 kHz) to the base of A2Q1 through a 1-uf capacitor. Connect an oscilloscope to the base of A2Q1. Adjust the FREQ B control and FREQ B range multiplier switch for a Generator frequency of 1 kHz. Set the OUTPUT selector switch to B and adjust the signal generator output level to obtain a 10-millivolt peak-to-peak signal, as displayed on the oscilloscope.		
		b. Connect the oscilloscope to the collector of A2Q1 and note the display; it should be a sinusoidal waveform having a peak-to-peak amplitude of approximately 75 millivolts.	b. Go to step c.	b. Check A2Q1 and associated circuitry.
		c. Connect the oscilloscope to the collector of A2Q2 and note the display; it should be a sinusoidal waveform having a peak-to-peak amplitude of approximately 70 millivolts.	c. Go to step d.	c. Check A2Q2 and associated circuitry.
		d. Connect the oscilloscope to the collector of A2Q3 and note the display; it should be a sinusoidal waveform having a peak-to-peak amplitude of approximately 13 volts.	d. Go to step e.	d. Check A2Q3 and associated circuitry.
		e. Connect the oscilloscope to the emitter of A2Q6 and note the display; it should be a sinusoidal waveform having a peak-to-peak amplitude of approximately 13 volts.	e. Check S2 and associated circuitry.	e. Check A2Q4, A2Q5, A2Q6 and associated circuitry.

(Cont'd)

TABLE 4-4. SYSTEMATIC TROUBLE LOCALIZATION (Cont'd)

No.	Symptom	Test Procedure	If Indication Is Normal	If Indication Is Abnormal
3	Neither tone A nor tone B signal is obtainable.	a. Check tone A oscillator board A1 (refer to 1 above). Check tone B oscillator board A2 (refer to 2 above).	a. Go to step b.	a. Effect the necessary repairs and/or replacements.
		b. With oscillator boards A1 and A2 properly seated in their receptacles, adjust the Generator for a single-tone output at 1 kHz. Connect an oscilloscope to the collector of A3Q1 and note the oscilloscope display; it should be a sinusoidal waveform having a peak-to-peak amplitude of approximately 0.03 volts.	b. Go to step c.	b. Check S3A, A4R28 and associated circuitry (if tone A oscillator is being employed); check S3A, A4R29 and associated circuitry (if tone B oscillator is being employed). Check A3Q1 and associated circuitry.
		c. Withdraw summing amplifier board A3. Insert the extender board into the vacated connector and mount A3 atop the extender board. Connect the oscilloscope to the collector of A3Q2 and note the display; it should be a sinusoidal waveform having a peak-to-peak amplitude of approximately 0.03 volts.	c. Go to step d.	c. Check A3Q2 and associated circuitry.
		d. Connect the oscilloscope to the A4J3-S and note the display; it should be a sinusoidal waveform having a peak-to-peak amplitude of approximately 7 volts.	d. Check attenuator circuitry.	d. Check A3Q5, A3Q6, A3Q7, A3Q8 and associated circuitry.

With the knob removed, loosen the two setscrews that secure the setting of the dial to the shaft. Exercise extreme care not to rotate the shaft while slipping the dial. Once the dial has been slipped, carefully tighten the two setscrews to secure the dial to the shaft.

c. Adjust A4R2 (A4R4) fully counterclockwise.

d. Set the FREQ A (FREQ B) control until 200 on the dial lines up with the fiducial marker on the front panel. Then adjust R1 (R3) until the frequency counter indicates 2000 Hz.

e. Rotate the FREQ A (FREQ B) control shaft to obtain a dial indication of 20 and note the counter indication; it should read between 194 and 206 Hz.

f. Rotate the FREQ A (FREQ B) control shaft to obtain a dial indication of 200 and set the FREQ A (FREQ B) range multiplier switch to X100. Note and record the counter indication; it should be between 19,400 and 20,600 Hz. If it does not read between these limits, continue to step h.

g. Rotate the FREQ A (FREQ B) control shaft to obtain a dial indication of 20. Note the counter indication; it should read between 1,940 and 2,060 Hz.

h. Rotate the FREQ A (FREQ B) control shaft to obtain a dial indication of 200 and set the FREQ A (FREQ B) range multiplier switch to X1. Note and record the counter reading; it should read between 194 and 206 Hz. If it does not, proceed to step j.

i. Rotate the FREQ A (FREQ B) control shaft to obtain a dial indication of 20. Note the counter indication; it should read between 19.4 and 20.6 Hz.

j. Divide the counter reading recorded in step f by 10. Multiply the counter reading recorded in step h by 10. Add these two frequencies to 2000 and divide the total by 3. Record this frequency.

k. Set the FREQ A (FREQ B) range multiplier switch to X10 and rotate the FREQ A (FREQ B) control shaft to obtain a counter indication equal to that recorded in step j.

l. Slip the dial, as directed in step b, to obtain an indication of 200.

m. Repeat steps b through l until the frequency calibration accuracy of ±3% is obtained over the entire 20 Hz to 20 kHz range.

n. Replace the knob on the control shaft and secure the knob by tightening its setscrew.

4-19. VOLTAGE MEASUREMENTS.

4-20. Voltage measurements for each of the transistor stages. in the Generator are given in tables 4-5 and 4-6. These voltages were obtained using an RCA Model WV-98C vtvm and the Generator adjusted to produce a single-tone output of 10 kHz.

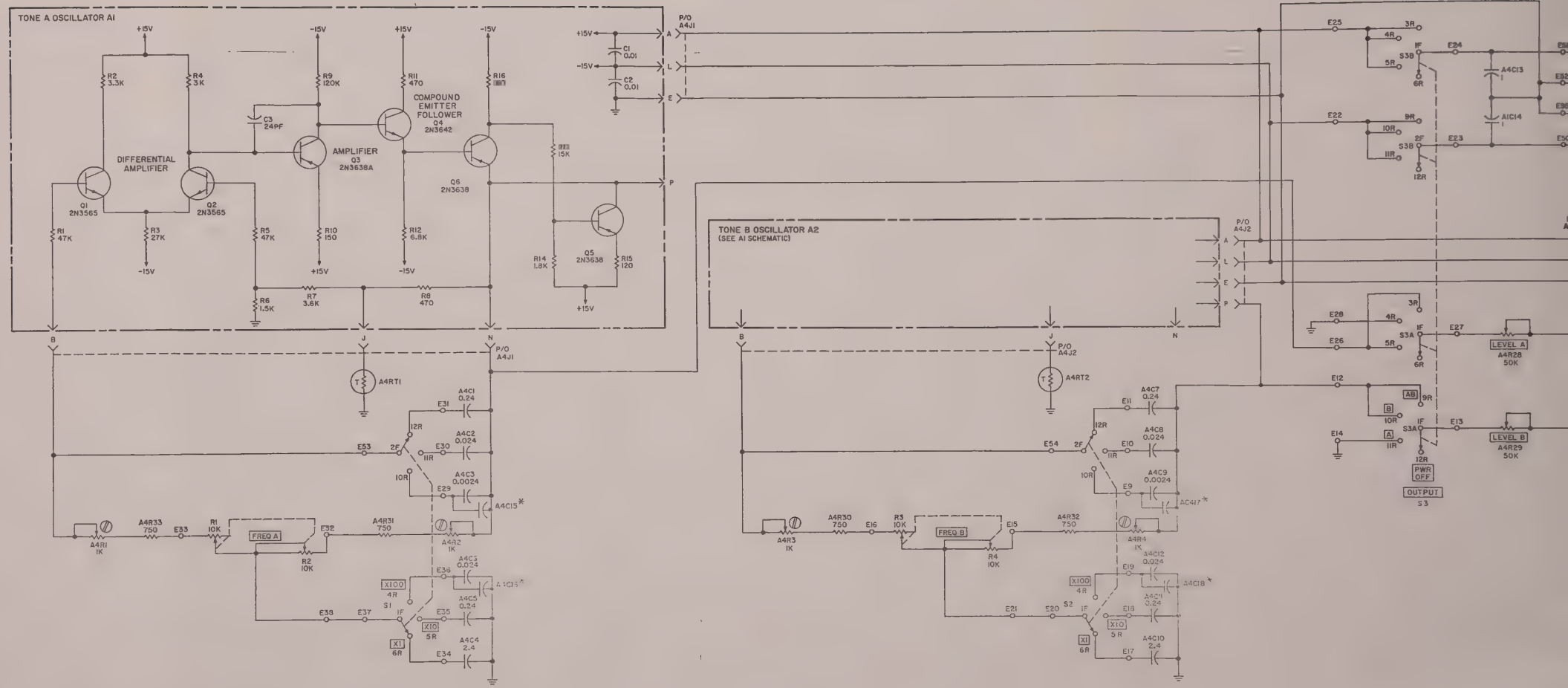
TABLE 4-5. VOLTAGE MEASUREMENTS, OSCILLATOR BOARDS A1 AND A2

Reference Designation	Transistor Type	Terminal Voltage		
		Emitter	Base	Collector
Q1	2N3565	-0.6	0	+13.8
Q2	2N3565	-0.6	0	+14.3
Q3	2N3638A	+14.8	+14.3	0
Q4	2N3642	-0.6	0	+14
Q5	2N3638	+12.6	+12	0
Q6	2N3638	0	-0.6	-11.4

TABLE 4-6. VOLTAGE MEASUREMENTS, SUMMING AMPLIFIER BOARD A3

Reference Designation	Transistor Type	Terminal Voltage		
		Emitter	Base	Collector
Q1	2N3565	-0.5	0	+13.7
Q2	2N3565	-0.5	0	+14.3
Q3	2N3638A	+15	+14.3	+0.9
Q4	2N3642	+0.2	+0.9	+13.1
Q5	2N3642	+0.75	+1.3	+14.7
Q6	2N3642	+1.8	+0.75	+14.5
Q7	2N3638	+0.15	-0.4	-14.3
Q8	2N3642	-14.7	-14.3	+0.15

SECTION V
SCHEMATIC DIAGRAMS


TONE A OSCILLATOR A1
DIFFERENTIAL AMPLIFIER
COMPOUND EMITTER FOLLOWER Q4 2N3642
AMPLIFIER Q3 2N3638A
Q1 2N3565
Q2 2N3565
Q5 2N3638
Q6 2N3638
P/O A4J1
TONE B OSCILLATOR A2
(SEE A1 SCHEMATIC)
P/O A4J2
A4RT1
A4RT2
FREQ A
FREQ B
LEVEL A A4R28 50K
LEVEL B A4R29 50K
PWR OFF
OUTPUT S3
106-0502 00

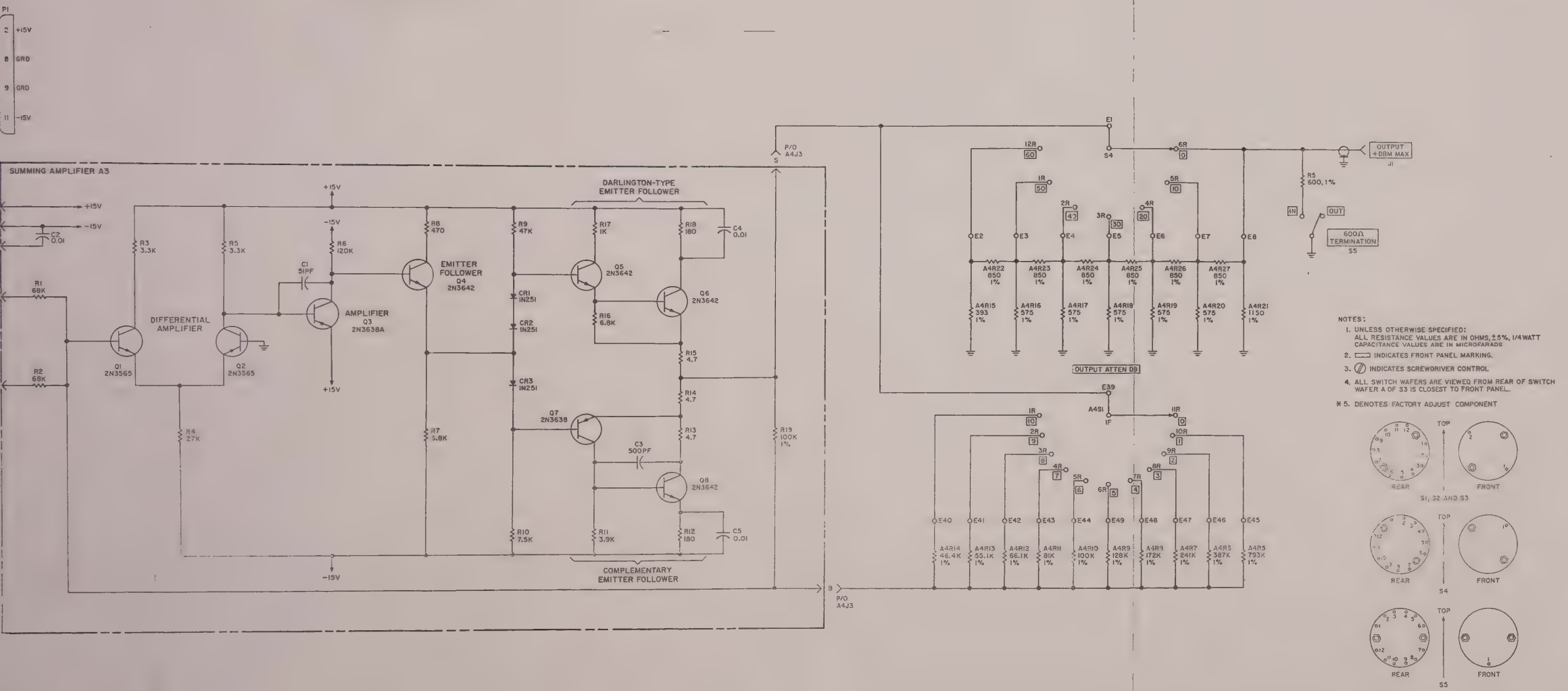


Figure 5-1. Schematic Diagram, Generator

SECTION VI
PARTS LIST

6-1. INTRODUCTION.

6-2. This parts list section includes all pertinent data necessary to locate, identify, and procure additional parts for the equipment. Parts are listed alpha-numerically by reference symbol and include all replaceable items such as electronic, electro-mechanical, and mechanical parts of the equipment. In some cases, values, ratings and manufacturer sources shown are nominal and variations may be found. Satisfactory replacement may be made with either the listed component or an exact replacement of the part(s) removed from the equipment.

6-3. ORDERING INFORMATION.

6-4. The following instructions will aid in ordering parts from the Parts Lists, table 6-2.

a. Address all inquiries or orders to:

CUSTOMER SERVICE
Department 500-1
The Singer Company
Metrics Division
915 Pembroke Street
Bridgeport, Connecticut, 06608

b. Include the following information:

1) Model and Serial Number of instrument.

2) Singer Part Number.

3) Reference Symbol Number.

4) Description (as shown on list).

6-5. HOW TO USE THE PARTS LIST.

6-6. Paragraphs 6-7 through 6-11 describe the use and meaning of the five columns included in the parts list (see figure 6-1).

6-7. REF SYMBOL COLUMN. The Ref Symbol Column (1, figure 6-1) contains an alpha-numerical listing of parts as they appear on equipment chassis, illustration, or schematic. The reference designation identifies the parts as to their component function in the instrument.

6-8. DESCRIPTION COLUMN. The Description Column (2, figure 6-1) contains the identification of component parts including all pertinent specifications and Singer part number. When the description column is used for a part which is identical to a part which has already been described; SAME AS (3) is used along with the reference symbol of the previously used part. In these instances, columns 3, 4, 5 are left blank. When the description column is used for a reference symbol for which no part exists; NOT USED (4) is placed in the column. In these instances, columns 3, 4, 5, are left blank.

6-9. MANUFACTURER'S PART NUMBER COLUMN. The Manufacturer's Part Number column (5, figure 6-1) contains the part number as designated by the manufacturer of the part.

6-10. MFR'S CODE COLUMN. The Mfr's Code column (6, figure 6-1) references the manufacturer by an assigned code number as listed in Federal Supply Code Handbook H4-2. For manufacturers not listed in H4-2, a letter code will be assigned. Table 6-1 includes the manufacturer and his code designation.

6-11. MAINT QTY COLUMN. The Maint Qty column (7, figure 6-1) contains the number of additional components recommended to keep the equipment at an optimum performance level. The recommended number of components in the Maint Qty column is based on 2000 hours of equipment operation.

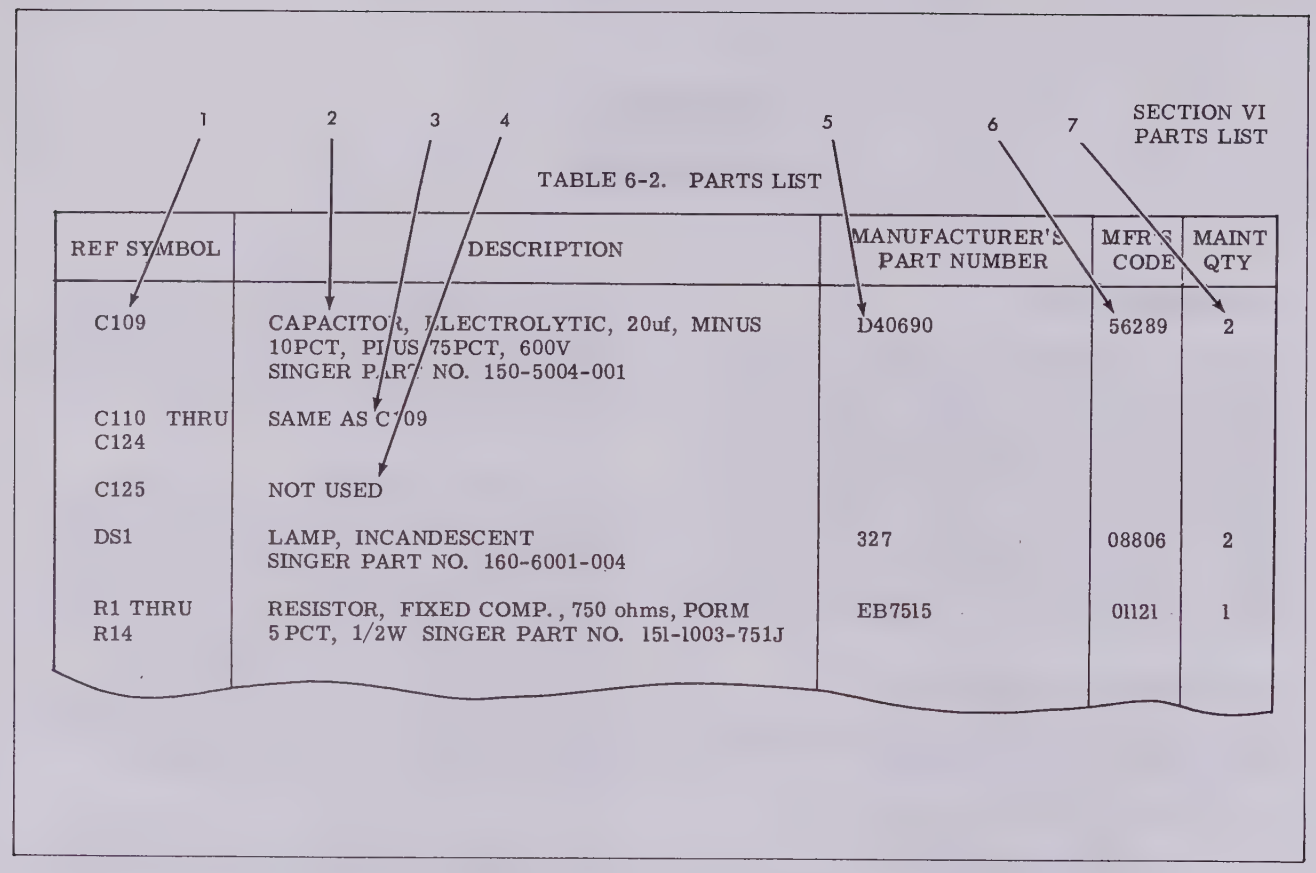


Figure 6-1. Parts List Sample

TABLE 6-1. MANUFACTURER'S CODE

Number	Name
01121	Allen-Bradley Co. Milwaukee, Wis.
02660	Amphenol-Borg Electronics Co. Maywood, Ill.
02777	Hopkins Engineering Co. San Fernando, Calif.
07263	Fairchild Camera and Instrument Corp. Semiconductor Division Mountain View, Calif.
12126	Kidco Inc. Medford, N.J.
14752	Electro-Cube Inc. Pasadena, Calif.
16665	The Singer Co., Metrics Division Bridgeport, Conn.
18065	Samarius Inc. Derby, Conn.
71590	Centralab Division of Globe-Union Inc. Milwaukee, Wis.
72136	Electro-Motive Mfg. Co. Inc. Willimantic, Conn.
73138	Beckman Instruments Inc. Helipot Division Fullerton, Calif.
76854	Oak Mfg. Co. Crystal Lake, Ill.
78488	Stackpole Carbon Co. St. Marys, Pa.
80294	Bourns Inc. Riverside, Calif.
81349	Military Specifications
95354	Methode Mfg. Co. Chicago, Ill.
B	Standard Telephones and Cables LTD. London, W.C. 2., England

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
J1	CONNECTOR,JACK SINGER PART NO.168-4006-001	UG-1094/U	81349	1
P1	CONNECTOR,PLUG, 16 PIN SINGER PART NO. 556166-045	26-159-16	02660	1
R1 THRU R4	RESISTOR,VARIABLE 10K OHMS	149-0165-001	16665	1
R5	RESISTOR,FIXED,PREC.,600 OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B6000F	C1/2E6010HMSPORM1PCT	12126	1
S1 AND S2	SWITCH,ROTARY,3 POSITIONS SINGER PART NO. 556146-711	399223A	76854	
S3	SWITCH,ROTARY,4 POSITIONS SINGER PART NO. 556146-712	399225A	76854	
S4	SWITCH,ROTARY,7 POSITIONS SINGER PART NO. 556146-708	399217A	76854	
S5	SWITCH,SLIDE,SPST SINGER PART NO. 556146-713	SS47	78488	
A1	OSCILLATOR ASSY	103-1280-001	16665	1
A1C1 AND A1C2	CAPACITOR,FIXED,CERAMIC DISC, 0.01 UF,250V SINGER PART NO. 556060-146	DA140-172B	71590	1
A1C3	CAPACITOR,FIXED,DIPPED MICA, 24 PF, PORM 5 PCT,500V SINGER PART NO. 150-2002-240EJO	DM15E240J0500WV4CR	72136	1
A1Q1 AND A1Q2	TRANSISTOR SINGER PART NO. 556146-254	2N3565	81349	1
A1Q3	TRANSISTOR SINGER PART NO. 556146-401	2N3638A	81349	1
A1Q4	TRANSISTOR SINGER PART NO. 556146-702	2N3642	07263	
A1Q5 AND A1Q6	TRANSISTOR SINGER PART NO. 556146-255	2N3638	81349	1
A1R1	RESISTOR,FIXED,COMP., 47K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-473J	CB4735	01121	1
A1R2	RESISTOR,FIXED,COMP., 3.3K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-332J	CB3325	01121	1
A1R3	RESISTOR,FIXED,COMP., 27K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-273J	CB2735	01121	1
A1R4	RESISTOR,FIXED,COMP., 3K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-302J	CB3025	01121	1
A1R5	SAME AS A1R1			
A1R6	RESISTOR,FIXED,COMP., 1.5K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-152J	CB1525	01121	1
A1R7	RESISTOR,FIXED,COMP., 3.6K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-362J	CB3625	01121	1
A1R8	RESISTOR,FIXED,COMP., 470 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-471J	CB4715	01121	1
A1R9	RESISTOR,FIXED,COMP., 120K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-124J	CB1245	01121	1

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A1R10	RESISTOR,FIXED,COMP., 150 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-151J	CB1515	01121	1
A1R11	SAME AS A1R8			
A1R12	RESISTOR,FIXED,COMP., 6.8K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-682J	CB6825	01121	1
A1R13	RESISTOR,FIXED,COMP., 15K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-153J	CB1535	01121	1
A1R14	RESISTOR,FIXED,COMP., 1.8K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-182J	CB1825	01121	1
A1R15	RESISTOR,FIXED,COMP., 120 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-121J	CB1215	01121	1
A1R16	RESISTOR,FIXED,COMP., 180 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-181J	CB1815	01121	1
A2	OSCILLATOR ASSY /SAME AS A1/ SEE A1 OSCILLATOR ASSY FOR LIST OF REPLACEABLE PARTS	103-1280-001	16665	1
A3	SUMMING AMPLIFIER ASSY	103-1277-001	16665	1
A3CR1 THRU A3CR3	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556118-046	IN251	81349	1
A3C1	CAPACITOR,FIXED,DIPPED MICA, 51 PF, PORM 5 PCT,500V SINGER PART NO. 150-2002-510EJO	DM15E510J0500WV4CR	72136	1
A3C2	SAME AS A1C1			
A3C3	CAPACITOR,FIXED,DIPPED MICA, 500 PF, PORM 5 PCT,500V SINGER PART NO. 150-2002-501EJO	DM15E501J0500WV4CR	72136	1
A3C4 AND A3C5	SAME AS A1C1			
A3Q1 AND A3Q2	SAME AS A1Q1			
A3Q3	SAME AS A1Q3			
A3Q4 THRU A3Q6	SAME AS A1Q4			
A3Q7	SAME AS A1Q5			
A3Q8	SAME AS A1Q4			
A3R1 AND A3R2	RESISTOR,FIXED,COMP., 68K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-683J	CB6835	01121	1
A3R3	SAME AS A1R2			
A3R4	SAME AS A1R3			
A3R5	SAME AS A1R2			
A3R6	SAME AS A1R9			
A3R7	SAME AS A1R12			

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A3R8	SAME AS A1R8			
A3R9	SAME AS A1R1			
A3R10	RESISTOR,FIXED,COMP., 7.5K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-752J	CB7525	01121	1
A3R11	RESISTOR,FIXED,COMP., 3.9K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-392J	CB3925	01121	1
A3R12	SAME AS A1R16			
A3R13 THRU A3R15	RESISTOR,FIXED,COMP., 4.7 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-4R7J	CB4R75	01121	1
A3R16	SAME AS A1R12			
A3R17	RESISTOR,FIXED,COMP., 1K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-102J	CB1025	01121	1
A3R18	SAME AS A1R16			
A3R19	RESISTOR,FIXED,FILM, 100K OHMS,PORM 1 PCT, 1/4W SINGER PART NO. 556146-714	RN60D1003F	81349	1
A4	MAIN CHASSIS ASSY MOTHER BOARD	103-1324-001	16665	1
A4C1	CAPACITOR,FIXED,METALLIZED MYLAR, 0.24 UF, PORM 2 PCT,100V SINGER PART NO. 556146-638	217A1B244G	14752	1
A4C2	CAPACITOR,FIXED,METALLIZED MYLAR, 0.024 UF, PORM 2 PCT,100V SINGER PART NO. 556146-639	217A1B243G	14752	1
A4C3	CAPACITOR,FIXED,METALLIZED MYLAR, 0.0024 UF, PORM 2 PCT,100V SINGER PART NO. 556146-640	217A1B242G	14752	1
A4C4	CAPACITOR,FIXED,METALLIZED MYLAR, 2.4UF, PORM 2 PCT,100V SINGER PART NO. 556146-637	217A1B245G	14752	1
A4C5	SAME AS A4C1			
A4C6	SAME AS A4C2			
A4C7	SAME AS A4C1			
A4C8	SAME AS A4C2			
A4C9	SAME AS A4C3			
A4C10	SAME AS A4C4			
A4C11	SAME AS A4C1			
A4C12	SAME AS A4C2			
A4C13 AND A4C14	CAPACITOR,FIXED,METALLIZED PAPER, 1 UF, PORM 10 PCT,50V SINGER PART NO. 556118-143	1PP5D	02777	1
A4C15 THRU A4C18	FACTORY ADJUSTED COMPONENT			

TABLE 6-2. PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A4J1 THRU A4J3	CONNECTOR,JACK, 15 PIN SINGER PART NO. 556146-635	71-6015-1300	95354	
A4RT1 AND A4RT2	THERMISTOR SINGER PART NO. 556146-709	STCR54	B	
A4R1 THRU A4R4	RESISTOR,VARIABLE, 1K OHM SINGER PART NO. 556146-516	62PR1K	73138	
A4R5	RESISTOR,FIXED,PREC., 793K OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B7933F	C1/2793KOHMPORM1PCT	12126	1
A4R6	RESISTOR,FIXED,PREC., 387K OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B3873F	C1/2387KOHMPORM1PCT	12126	1
A4R7	RESISTOR,FIXED,PREC., 241K OHMS,PORM .5 PCT, 1/2W SINGER PART NO. 151-1008-B2413D	C1/2241KOHMPORM.5PCT	12126	1
A4R8	RESISTOR,FIXED,PREC., 172K OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B1723F	C1/2172KOHMPORM1PCT	12126	1
A4R9	RESISTOR,FIXED,PREC., 128K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1008-B1283J	C1/2128KOHMPORM5PCT	12126	1
A4R10	RESISTOR,FIXED,PREC., 100K OHMS,PORM .5 PCT, 1/2W SINGER PART NO. 151-1008-B1003D	C1/2100KOHMPORM.5PCT	12126	1
A4R11	RESISTOR,FIXED,PREC., 81K OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B8102F	C1/2810KOHMPORM1PCT	12126	1
A4R12	RESISTOR,FIXED,PREC., 66.1K OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B6612F	C1/266.1KOHMPORM1PCT	12126	1
A4R13	RESISTOR,FIXED,PREC., 55.1K OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B5512F	C1/255.1KOHMPORM1PCT	12126	1
A4R14	RESISTOR,FIXED,PREC., 46.4K OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B4642F	C1/246.4KOHMPORM1PCT	12126	1
A4R15	RESISTOR,FIXED,PREC., 393 OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B3930F	C1/2393OHMSPORM1PCT	12126	1
A4R16 THRU A4R20	RESISTOR,FIXED,PREC., 575 OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B5750F	C1/2575OHMSPORM1PCT	12126	1
A4R21	RESISTOR,FIXED,PREC., 1150 OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B1151F	C1/21151OHMPORM1PCT	12126	1
A4R22 THRU A4R27	RESISTOR,FIXED,PREC., 850 OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B8500F	C1/2850OHMSPORM1PCT	12126	1
A4R28 AND A4R29	RESISTOR,VARIABLE, 50K OHMS SINGER PART NO. 151-0014-503P	3068-P-503	80294	1
A4R30 THRU A4R33	RESISTOR,FIXED,COMP., 750 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-751J	CB7515	01121	1
A4S1	SWITCH,ROTARY,11 POSITIONS SINGER PART NO. 556146-708	399217A	76854	1

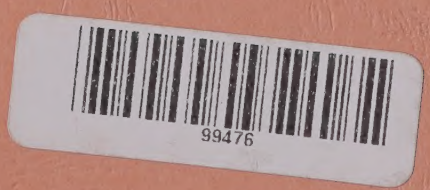
SHIPMENT DAMAGE CLAIM

The instrument should be tested as soon as it is received. If it fails to operate properly or is damaged in any way, a claim must be filed with the carrier. Have carrier agent inspect damage to instrument and packing crate and forward us a copy of his written report. You will then be advised of replacement or repair arrangements and disposition of the equipment. Please include model number, type number and serial number when referring to this instrument for any reason.

REPACKING FOR SHIPMENT

The instrument should be packed in the original carton. If unusable or not available, use a wooden box with approximately three inches of excelsior or other shock-absorbing material surrounding the instrument. If desired, packing services of a local transfer and storage company may be employed.

SINGER
INSTRUMENTATION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